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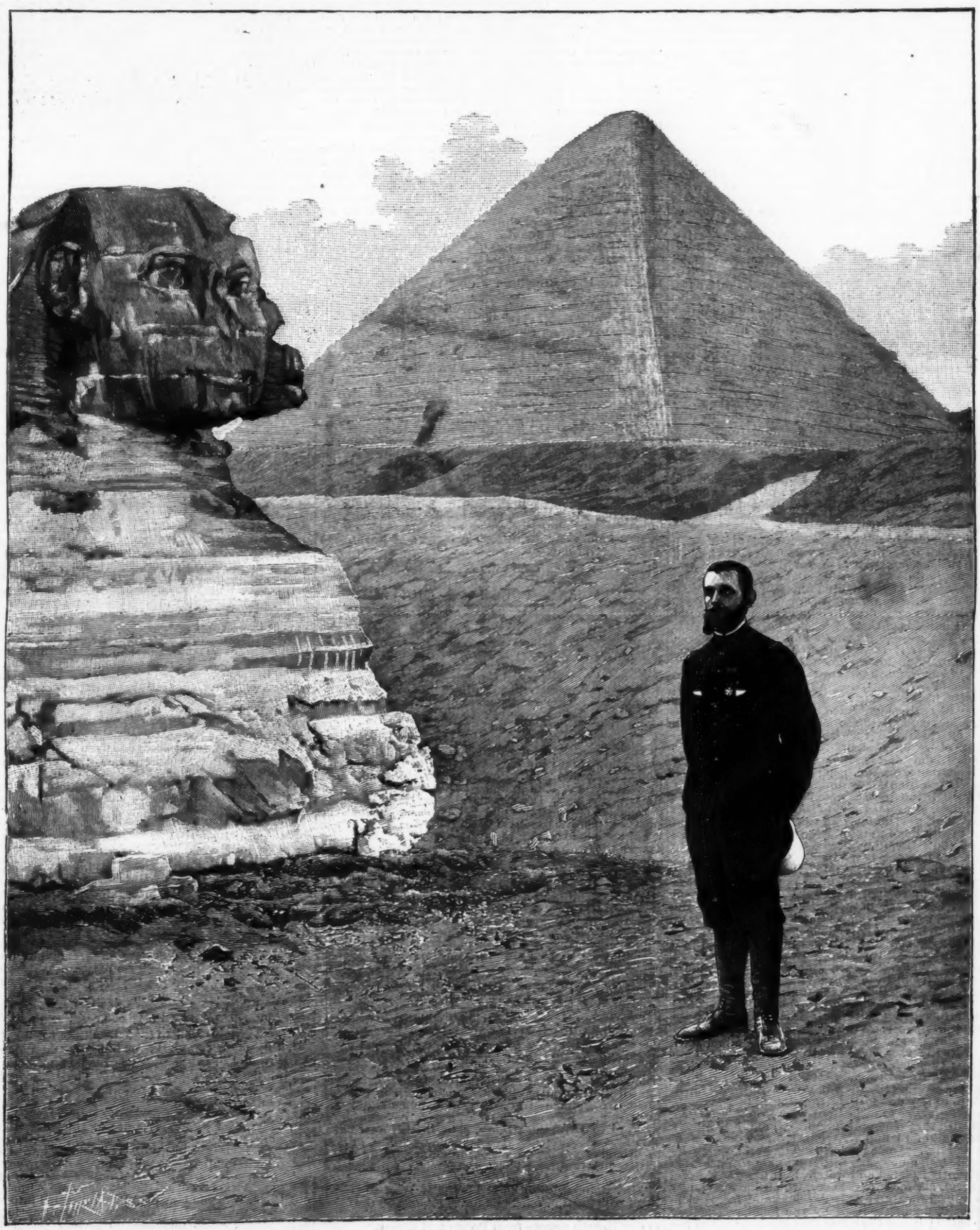


CAPTAIN MARCHAND.

FROM A PHOTOGRAPH TAKEN IN NOVEMBER.

MARCHAND BEFORE THE PYRAMIDS.

DURING his recent sojourn at Cairo, Captain Marchand, accompanied by Captain Baratier and M. Lefèvre Pontalis, second secretary of the French legation, made an excursion to the Mena House Hotel and to the Pyramids. A photographer happened to be on the spot, and his camera has taken the gallant explorer standing in an attitude of contemplation before the Sphinx. Did the hero of Fashoda think of questioning the symbolic monster? It is hardly likely; for at the time he was only too well informed of the solution of the Egyptian problem, and the curiosity of the tourist alone is sufficient to explain this *rapprochement*, in which the reader will see a curious example of photographic reporting.—We are indebted to L'Illustration for the engraving.

THE SMELL OF EARTH.

By G. CLARKE NUTTALL, B.Sc.

A BRIGHT, fine evening after a day of rain is one of Nature's compensations. The air is peculiarly sweet and fresh, as though the rain had washed all evil out of it. The mind, relieved from the depressing influence of continuous rain, is exhilarated, and, above all, the strong smell of the earth rises up with a scent more pleasing than many a fragrant essence. In the town, indeed, this earthy smell is often obscured by the bricks and mortar which cover the land, and by the stronger, less wholesome, odors of human life, but in the country it has full sway, and fills the whole air with its presence. Even a slight shower, particularly after drought, is sufficient to bring out the sweet, familiar smell of the land and thrust it upon our notice.

The smell of freshly turned earth is often regarded by country-lovers as one of the panaceas for the ills of the flesh, and "follow a plowshare and you will find health at its tail" has proved a sound piece of advice to many a weakly town-sick one, over whose head the threatenings of consumption hung like the sword of Damocles, though it is possible that it is the fresh air, and more especially the sunshine, which are the saving media, and not the mere smell.

But what do we know about this characteristic smell of the soil? Can we regard it as the mere attribute of the soil as a simple substance, such an attribute as is, for instance, the peculiar smell of leather, or the odor of India rubber; or can we go deeper and find that it is really an expression of complexity below?

Strangely enough, this is the case, for the smell of damp earth is one of the latest signposts we have found which lead us into a world which, until recently, was altogether beyond our ken. It points us to the presence, in the ground beneath us, of large numbers of tiniest organisms, and not merely to their presence only, but to their activity and life, and reveals quite a new phase of this activity. A handful of loose earth picked up in a field by the hedgerow, or from a garden, no longer represents to us a mere conglomeration of particles of inorganic mineral matter, "simply that and nothing more;" we realize now that it is the home of myriads of the smallest possible members of the great kingdom of plants, who are, in particular, members of the fungus family in that kingdom, plants so excessively minute that their very existence was undreamt of until a few years ago.

Some faint idea of their relative size, and of the numbers in which they inhabit the earth, may be gleaned from the calculations of an Italian, Signor A. Magiora, who, a short time ago, made a study of the question. He took samples of earth from different places round about Turin and examined them carefully. In ordinary cultivated agricultural soil he found there would be eleven millions of these germs in the small quantity of a gramme, a quantity whose smallness will be appreciated when it is remembered that a thousand grammes only make up about two and a quarter pounds of our English measure. Thus, a shovelful of earth would be the home of a thousand times eleven millions of bacteria—but the finite mind cannot grasp numbers of such magnitude. In soil taken from the street, and, therefore, presumably more infected with germs, he calculated that there was the incredible number of seventy-eight million bacteria to the gramme. Sandy soil is comparatively free from them, only about one thousand being discovered in the same amount taken from sandy dunes outside Turin.

But though the workers were hidden, yet their works were known, for what they do is out of all proportion to what they are; in fact, they perform the deeds of giants, not those of veriest dwarfs. "By their works shall ye know them" might be a fitting aphorism to describe the bacteria of the soil. And the nature of their deeds is widely various, for, though the different groups are members of one great family, yet, like the individuals of a human family that is well organized, they have each of them their special vocation. In the spring time, when the sun warms the chilly earth, they act upon the husks that have protected the seeds against the rigors of the winter, and crumble them up so that the seedling is free to grow; they break down the stony wall of the cherry and plum which has hitherto imprisoned the embryo; and then, when the young plant starts, they attach themselves to its roots, assist it to take in all sorts of nutriment from air and soil, and thus help it in its fight through life, and when its course has run they decently bury it. They turn the green leaves and the woody stem and the dark root back into the very elements from which they were built up; they effect its decay and putrefaction, and resolve it into earth again. "Dust to dust, ashes to ashes," is the great life work of the earth bacteria.

But up to the present the fresh smell of the earth, the smell peculiar to it, has not been in any way associated with these energetic organisms, and it is quite a new revelation to find that it is a direct outcome of their activity. Among the many bacteria which inhabit the soil, a new one, hitherto unknown, has been just recently isolated and watched. It lives, as is usual with them, massed into colonies, which have a chalky white appearance, and as it develops and increases in numbers it manifests itself by the familiar smell of damp earth; hence the name that has been given it—Cladothrix odorifera. Taken singly, it is a colorless, thread-like body, which increases numerically by continuous subdivisions into two in the direction of its length. It derives its nutriment from substances in the soil which either are, or have been, touched by the subtle influence of life, and in the processes of growth and development it evolves from these materials a compound whose volatilizing gives the odor in question. This compound has not yet been fully examined; it is not named, nor have all its properties been satisfactorily elucidated, but two facts concerning it stand out clearly. One is that it is the true origin of the smell that we have hitherto attributed to earth simply, and the other that it changes into vapor under the same conditions as water does. Therefore, when the sun, shining after the rain, draws up the water from the earth in vapor form, it draws up, too, the odorous atoms of this newly-found compound, and these atoms, floating in the air, strike on our olfactory nerves, and it is then we exclaim so often, "How fresh the earth smells after the rain."

Though moisture to a certain extent is a necessary condition of the active work of these bacteria, yet the chief reason why the earthy smell should be specially noticeable after the rain is probably because this compound has been accumulating in the soil during the wet period. We only smell substances when they are in vapor form, and since the compound under consideration has precisely the same properties in this respect as water, it will only assume gaseous form when the rain ceases. The bacteria have, however, been hard at work all the time, and when the sun shines and drying begins, then the accumulated stores commence their transformation into vapor, and the strong smell strikes upon our senses. For the same reason we notice a similar sort of smell, though in a lesser degree, from freshly turned earth. This is more moist than the earth at the surface, and hence, on exposing it, evaporation immediately begins, which quickly makes itself known to us through our olfactory nerves.

It may also have been remarked that this particular odor is always stronger after a warm day than after a cold one, and is much more noticeable in summer than in winter. This is because moderate warmth is highly conducive to the greater increase of these organisms, and, in fact, in the summer they are present in far larger numbers and exhibit greater vitality than in the winter, when they are often more or less quiescent.

Two other characteristics of Cladothrix odorifera are worthy of notice as showing the tenacity with which it clings to life. It is capable of withstanding extremely long periods of drought without injury; its development may be completely arrested (for water in some degree is a necessity with all living things, from highest to lowest), but its vitality remains latent, and with the advent of water comes back renewed activity. But besides drought it is pretty well proof against poisons. It can even withstand a fairly large dose of that most harmful poison to the vegetable world corrosive sublimate. Hence any noxious matter introduced into the soil would harm it little ultimately; the utmost it could do would be to retard it for a time.

This, then, is the history of the smell of earth as scientists have declared it unto us, and its recital serves to further point the moral that the most obvious, the most commonplace things of everyday life—things that we have always taken simply for granted without question or interest—may yet have a story hidden beneath them. Like signposts in a foreign land, they may be speaking, though in a language not always comprehended by us, of most fascinating regions, regions we may altogether miss to our great loss, if we neglect ignorantly the directions instead of learning to comprehend them.—Knowledge.

THE GULAR POUCH OF THE GREAT BUSTARD (OTIS TARDA).

IN reviewing the history of the gular pouch of the great bustard, we have of necessity to trace the history of the explanation of two very different phenomena, which at last resolve themselves into complementary halves of a common whole. The first of these deals with the fact now known to all ornithologists, that several different species of bustard have the power of inflating the neck to an enormous degree, at intervals during that period when, as the poet has it, "fancy lightly turns to thoughts of love." It is one of the many methods of "showing off" to be found in such abundance among birds. At least three different versions have been given to explain how this inflation is brought about. The second, as hinted, is linked with that of the first. It concerns what is the main theme of this paper—the gular pouch. The very existence of such a structure has been denied by some, by others it has been held to be a receptacle for water, food, and air. Those who subscribed to this latter view, for the most part connected it more or less definitely with the curious love displays just referred to, and knew something of the habits of the living birds, which the others did not. The aim of the present paper is to give a sketch of these various conflicting interpretations and to draw attention to one or two minor points around which some doubt still seems to hover.

The earliest known indication of the possession of this faculty of inflating the neck by the great bustard dates back as far as 1681. This we owe to Sir Thomas Browne.* He remarks that "as a turkey hath an odde large substance without, so had this [Otis tarda] within the inside of the skinne." Here, however, we have nothing more than a bare statement drawing attention to the fact that the neck of this species of bustard differed from that of birds generally in this respect, and we are left to imagine that it is a constant character possibly possessed by both sexes in common. Some half century later a real contribution to our knowledge of the subject was made, which was destined to become the subject of much animated discussion. It concerns the gular pouch. This we owe to Dr. James Douglas, a British anatomist. The first mention of this was made by Albin, in 1740, for Douglas, it seems, did not announce his discovery during his lifetime. Albin's reference runs as follows:

"Dr. Douglas has observed in the Male [of the Great Bustard] two Stomachs, one for the Food and the other a Reservatory for Water to supply them, they feeding in dry Heaths remote from Ponds and Rivers."

A fuller account was given by Edwards, in 1747. This also deals with the discovery of Douglas, and repeats the interpretation originally given of the use of the pouch as a receptacle for water. "Its capacity," he says, "is full seven Wine Pints." It is further stated to be wanting in the hen.

M. Gauthier de la Peyronie, in his "Voyages de Pallas" (15a), says of the great bustard:

"Cet animal a un petit trou sous la langue, qui sert d'ouverture à une bourse aqueuse, qui est de la grosseur d'un oeuf d'oie."

That the great bustard—and probably also other species—possessed a gular pouch which was used as a receptacle for water, seems by this time to have been pretty generally believed. Thus, in 1781, Daines Barrington tells us of "a gentleman long resident at Morocco, where they frequently fly their hawks at bustards, hath also informed me that the cock makes use of this reservoir of liquid against these assailants, and commonly thus baffles them."

In the following year (1782) Bloch gave an account and figure of this pouch. He remarks: "Bey diesem grossem Vogel . . . siehet man einen Sack unter der Haut am Halse, dessen Oefnung unter der Zunge sichtbar ist. . . . Er ist weit, war bey einem alten Hahn, den ich untersuchte ein Fusslang, und erstreckte sich von der Kehle bis an die Brust." He then goes on to remark, "dass nur die Männchen allein mit diesem Sack versehen wären, so widerspricht diesem meine Erfahrung; denn ich habe ihn auch bey einen Weibchen gefunden." This is the first statement of its occurrence in the female, and one, we may remark, which has never yet been verified.

Naumann, in 1834, gives the results of his observations on this subject. After describing the general position of the pouch, and its opening under the tongue, he goes on to remark that "Er hat, wenn er mit Luft oder Wasser angefüllt ist, oft eine einfache, sehr langgezogene Eigestalt; gewöhnlicher noch ist er aber am Eingange enge; dann eiförmig erweitert und in der Mitte seiner Länge am weitesten; nachher wieder sehr verengert; dann wieder in Eiform, aber kürzer und nicht so stark wie oben erweitert und wie ein spitzes Ei geschlossen. . . . Er fasst eine ziemliche Menge Wasser, doch lange keine 8 Pfund, und man vermuthet, wiewohl ohne Grund, er sei ein ähnlicher Wasserbehälter wie der des Kameels, um Vorrath trinken zu können; aber warum war er denn dem Weibchen nicht auch gegeben?! Wasser fand ich überhaupt darin nur sehr wenig, nicht einmal einen Esslöffel voll, vielmehr ihn meistens ganz leer, nur ein Mal einige Grassamen, welche zufällig hinein gerathen zu sein schienen. Er scheint mir überhaupt mehr ein Luftals Wasserbehälter zu sein. Sein Zweck bleibt vor der Hand ein Räthsel, wie er dies schon lange war."

John Hunter apparently made a dissection of this pouch. He did not, however, subscribe to the prevalent opinion that it served as a receptacle for water; on the contrary, he candidly expresses that he does not know what its use may be. He describes it as "a large bag, as large as the thick part of one's arm. It terminates in a blind pouch below, but has an opening into it at the upper end from the mouth. This aperture will admit three or four fingers; it is under the tongue, and the fraenum linguae seems to enter it; and it seems to have a sphincter. What the use of this is I don't know. . . ."

None of the writers so far quoted seem to have connected this pouch with the phenomena of sexual display, probably because they had never witnessed the remarkable evolutions and contortions of this bird during its moments of ecstatic frenzy.

The credit of this interpretation, perhaps, belongs to Schneider. It seems, however, that he had never examined this pouch for himself, but relied on the accuracy of the observations of those more fortunate who had. Commenting upon Bloch's statement, which evidently much puzzled him, that the pouch was found in both sexes, he says: "Si mas solus sacco gulari gaudet, potest tum in amore eum forte inflare, ut collum intumescat. Contra si femina eundem habet, quod vix credo, alium tum eidem usum excogitare debemus." It is possible, however, that Schneider is indebted to the Emperor Friedrich the II. for the suggestion that the pouch may be occasionally and voluntarily inflated. Inasmuch as the latter, acquainted only with the external phenomena, drew attention to the "'grossum collum' possessed by both sexes of the great bustard, and especially the males 'tempore coitûs.'"

Quite another rendering was given as an explanation of this curious inflation of the neck by Degland (4), who writes:

"Je dois à mon honorable confrère, le docteur Dorin, de Châlons-sur-Marne, la connaissance d'un fait assez curieux et que je ne dois pas omettre. A l'époque des amours, il se développe dans le lieu même où s'insèrent les moustaches, une sorte de fanon, formé par une masse de tissu cellulaire graisseux, lâche, dont le volume est considérable, puisqu'il atteint et dépasse le poids d'un kilogramme. Cette sorte de fanon, qui occupe la partie antérieure et latérale du cou, est formée de deux masses qui se réunissent sur la ligne médiane à partir de la naissance des barbes jusqu'au bas du collier. C'est au moyen de muscles fauciers assez développés que l'oiseau peut imprimer des mouvements à cette masse, et par conséquent relever ou abaisser les plumes allongées qui s'y implantent. A la fin de juillet, elle commence à s'affaisser, les plumes tombent, se renouvellent, si bien qu'avant la fin de septembre il ne reste plus rien de cette grande masse de tissu cellulaire."

Owen, a year previously, had dissected a specimen, said to have been a male,* apparently for this purpose, and found "no trace of the gular pouch," thus so far confirming Degland. Mitchell, Yarrell, and later, Prof. Newton, all searched carefully for this pouch, and failed to find it; neither could they discover any opening under the tongue. The latter thus describes his search: "We cleared the skin away from the entire neck. . . . The neck was entirely clothed with cellular tissues in a most remarkable manner; they were very delicate, and so close to the skin, that even when we grazed the roots of the feathers, we occasionally cut them. On the blowpipe being inserted into one of the apertures thus made, a small bubble was immediately raised, which increased on greater power being applied, so as to form a considerable bag, perhaps three inches long, . . . it was plain . . . that none of these bags existed of themselves, but were the result

* The quotations from the earlier writers are taken for the most part from Prof. Newton's valuable article in The Ibis for 1862.

* Garrod suggested that this was probably a female.

of the membranes being forcibly ruptured by the pressure of the air."

Thus, then, at this time, so far as English ornithologists were concerned, the case for the existence of a gular pouch in the bustard had fallen through for lack of evidence. There seemed to be no other way of explaining the facts advanced by the older writers than that of supposing the "pouch" which they saw was artificial, caused by the rupture of cellular tissues. Unless, indeed, it was, as some suggested possible, present in some individuals but not in others. That the specimens dissected in England, says Prof. Newton

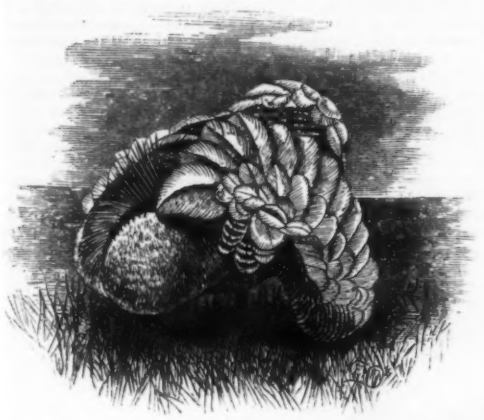


FIG. 1.—The Display of the Great Bustard, Otis tarda (after Wolf).

From Newton's "Dictionary of Birds."

(14), "were not all young, undeveloped birds, is also clear; but if any further evidence on this point is required, I would refer to the beautiful picture by Mr. Wolf (Fig. 1) which was drawn from an individual in our zoological gardens—an individual afterward the subject of one of the examinations here mentioned, though of which is not certain. No one who looks at that picture . . . can for a moment doubt that the original was a truly adult, mature, and fully developed bird."

Dr. Cullen (3), inspired by Prof. Newton's article (14), published the results of an examination of two males procured by him in Kustendjie, Bulgaria. In both of these a pouch was found, the largest of which he figured. The "opening under the tongue," he writes, "is large enough to admit readily the little finger, and is surrounded by what has all the appearance of a sphincter muscle . . . the pouch extended as far down as the furcular bone, enveloped closely throughout by a thin muscular covering exactly analogous in structure to the cremaster or platysma hyoides. The structure of the sac . . . is certainly not composed of cellular tissue, as stated by Degland; but . . . is a separate and distinct, though delicate bladder." After describing the very extraordinary evolutions of this bird during periods of display, and the great inflation of the neck with which they are accompanied, he remarks that "All these facts would certainly seem to favor the idea that the pouch is intended to contain air, and that by the action of the muscular tissue covering it conjointly with that of the sphincter at the mouth, the bustard may thereby be assisted . . . in producing the peculiar sound (resembling 'ook'), which is only to be heard during the time when the pouch is most developed. . . ."

These two preparations afterward came into the possession of the Royal College of Surgeons, and were described by Sir William Flower (6). The larger of the two sacs when empty measured nine inches in length, and when moderately distended with water was found to hold three imperial pints.

"Both of the sacks," he writes, "had within them a

FIG. 2.—The Display of the Australian Bustard, Eupodotis [Otis] australis (after Murie).

[This block was reproduced from a photograph of a colored lithograph, and is unfortunately not very clear.]

few short pieces of grass and leaves. There appear to be no glandular structures connected with the walls: indeed, the whole character of the sack points to its being a simple reservoir, probably for fluid, more analogous to the submandibular pouch of the pelican than to anything else in the class Aves. But in the absence of fuller information as to the economy and habits of the bird, I refrain from speculating upon the purpose of this singular and apparently inconstant organ."

With Dr. Cullen's investigations and their confirmation by Prof. Flower the existence of a pouch at least in some individuals was placed beyond cavil.

In 1868 Dr. Murie, then prosector of the Zoological Society, published his "Observations on the presence and function of the Gular Pouch in Otis kori and Otis australis." His remarks concerning the former were based upon the examination of a specimen which had recently died in the Gardens. In this, a distinct opening was found under the tongue leading into a small

FIG. 3.—The Oesophagus, Trachea, and Gular Pouch of a Specimen of Otis tarda, seen from the Side.

The crop is here drawn as in the actual preparation, projecting backward, and not forward as usual. (After Garrod.)

pouch "three inches in length and about an inch in transverse diameter." As touching the latter, his observations were based entirely on a bird then living in the Society's gardens. Of this he writes that he was pleased to find what he thinks "may be termed an exaggerated example of this organ in the Australian bustard." He continues: "This 'showing off' which is . . . a most extraordinary sight, may best be comprehended by a study of the accompanying sketch (Fig. 2) drawn from nature during one of those paroxysmal periods of excitement."

"The premonitory symptoms observable when the bustard is about to exhibit himself in the pride of lust . . . is a slight swelling of the inframandibular portion of the throat, while the head is thrown upward. Immediately afterward the neck swells and the feathers of the lower parts concomitantly bulge out and descend gradually downward in the form of a bag, oftentimes nearly reaching the ground.

"If the paroxysm is a strong one, then the tail is shot upward and forward over the back, the rectrices coming almost in contact with the neck.

"In this peculiar attitude, with bloated neck, hanging, baggy chest, elevated tail, and stiff, stilt-like legs, the creature struts about in a somewhat waddling manner, the elongated pouch swaying to and fro. The feathers of the throat start out on end; those of the depending sac are also raised, but less upright. While all this has taken place the bird seems to have gulped in air, or rather, with partly opened gape, to have taken a long, deep, and forced inspiration.

FIG. 4.—The Oesophagus and Trachea of the Specimen Eupodotis australis here described.

The oesophagus is much dilated, and, like that of the pouter pigeon, can be distended with air by the living bird. No trace of a pouch or crop is to be seen (after Garrod).

"The acme of inspiratory effort and strange attitude attained, the bustard begins to snap the mandibles together in a loud manner and utter a series of cooing sounds for a short interval of time. Usually and more frequently he struts toward the female bustards in a most dignified manner, or oblivious as to sex, totters up to any of the birds in the same inclosure."

Some years later (in 1873) the mouth of this identical bustard was examined by Prof. Garrod—Dr. Murie's successor to the prosectorship—with a view to finding a sublingual orifice such as obtains in O. tarda. There was no trace of any such orifice. This led Garrod "to doubt the correctness of Dr. Murie's inference, that because the neck of Eupodotis australis becomes distended much during the sexual season, therefore there is a gular pouch." The next year this bird died and was dissected by Garrod. As a result, "there was no gular pouch. There was no sublingual orifice. . . . How unsafe, therefore, is it to infer that because the neck distends and depends during the 'show-off,' there must be a sublingual pouch. It is quite possible that two

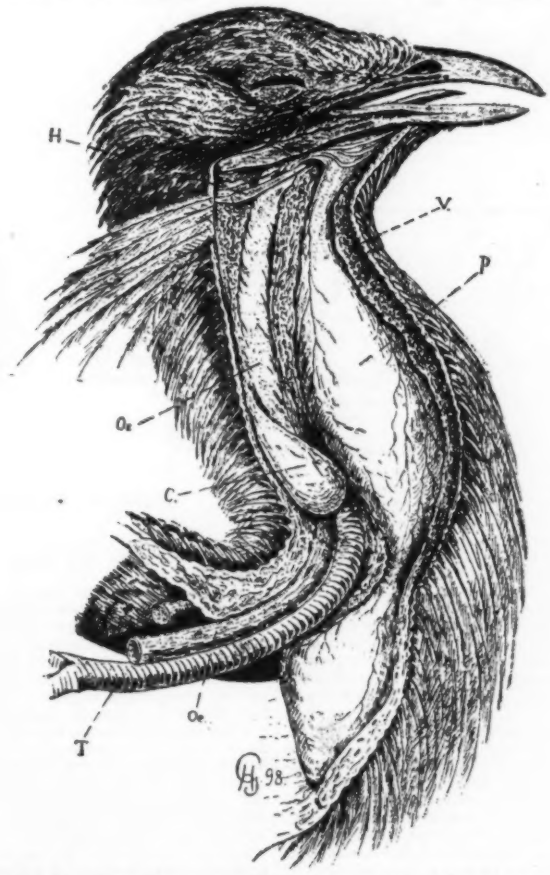


FIG. 5.—Dissection of the Right Side of the Neck of the Great Bustard, Otis tarda, to show the hour-glass-shaped Gular Pouch.

[Drawn by H. Grönvold from the specimen in the British Museum.] *C*, crop; *H*, hyoid; *Oe*, oesophagus; *P*, pouch; *T*, trachea; *V*, vascular tissue, investing the upper part of the pouch.

effects, very similar in appearance, in closely allied birds, may be the result of different mechanisms." A careful investigation showed that the cause of the inflation of the neck in this case was due to a highly extensible œsophagus. "Before dissection, by filling its cavity with air, the lower portion of the dilated œsophagus protruded downward considerably in front of the symphysis furculae, and formed the depending portion of the sac which was so conspicuous in the living animal." The two woodcuts (Figs. 3 and 4) kindly lent by Mr. Sclater for the present paper, are taken from Garrod's original paper.

Fig. 5 represents a dissection which the writer has just made of the gular pouch of an adult male till recently living in the Gardens of the Zoological Society, and which will shortly be exhibited in the Bird Gallery of the British Museum (Natural History). There is no need to describe in detail its form, capacity, and so forth: particulars of this kind will have been gathered already from the preceding pages. I might, however, remark that the sublingual aperture in my specimen was not ⊥-shaped, but circular, showing a hole large enough to admit the finger. Possibly this was due to relaxation of the muscles. After removal of the head and neck, the pouch was filled with spirit till it overflowed, the whole was then plunged into 70 per cent. spirit and left for some days. It was then taken out, and the skin from one side removed (Fig. 5). Underlying was a mass of fatty tissue, more or less completely investing the pouch. Along the anterior aspect of the neck, from the throat downward, this is engorged with blood. The pouch was loosely attached to this investiture by delicate strands of fibrous tissue. The constriction in this pouch probably corresponds with that described by Naumann, and occurs at the lower part of the neck where it bends between the furcula, between the arms of which the expanded terminal portion is received.

In conclusion I would point out: (1) That the characteristic "show-off" of the adult male Otis tarda ever takes place without the aid of a gular pouch is exceedingly improbable. But that this pouch is present throughout the year is another question, and is a point which has yet to be settled. It was not found in the specimen from which Wolf's beautiful drawing was taken, nor in numerous other cases in which it was carefully searched for. In the specimen lately dissected by myself it was, as is shown in the illustration (Fig. 5), very large. But this bird died in May, in the middle of its period of functional activity. (2) There is no evidence to show that it is ever present in the female. (3) The belief that this sac is ever used as a receptacle for water must now be regarded as utterly exploded. (4) It is not homologous with the "air-sacks" proper, belonging neither to the pulmonary nor to the nasopharyngeal system. Biziura lobata seems to be the only other bird besides the bustards possessing a precisely similar structure.—W. P Pycraft in Natural Science.

[Continued from SUPPLEMENT, No. 1198, page 19203.]

ROMAN CONSTRUCTION.*

By G. W. PERCY.

MANY barrel vaults of smaller dimensions were turned on armatures of two courses of bricks or tiles laid flatwise, the lower course laid continuous, of large bricks, and the second of smaller bricks covering the joints and forming blocks or bands as represented by Figs. 11, 12, and 13, the top course being laid in plaster or quick-setting mortar.

Of this type are many of the vaultings in the Baths of Caracalla.

When it came to groined vaultings, the Romans practiced the same economy in the employment of skilled labor and costly materials. It may be said in general that where practicable the Romans avoided the intersection of barrel vaults, but, where the requirements of the plan demanded it, they sought to make both barrel vaults of the same width, and where that was not practicable they usually stilted the narrower one so as to bring the top level with the large arch.

The centering and ribs were constructed in general as has been described for barrel vaults, but with the precaution of always having rigid ribs to form the groins (Figs. 14 and 15), or, if flat tiles were used, an extra course was laid along the line of the groin. (Fig. 16.)

In building circular domes, the same elaborate system of ribs and skeleton armature was carried out.

The dome of the Pantheon, the largest, oldest, and most perfect dome in masonry, and which some writers have described as of solid brickwork, others of solid concrete, proves by investigation to be of the fine rubble work we have described, with an elaborate system of ribs and arches incorporated.

Piranesi, the famous etcher of the last century, who devoted his life to producing in this manner the most perfect representations of the ruins and architectural features of Rome, made extensive investigations into the structure of the dome of the Pantheon while repairs were being made, and produced an etching of which Fig. 17 is a diagram.

The methods here presented are not the only ones employed by the Roman builders in constructing their vaults and arches. Many special devices were adopted as the difficulties and necessities presented themselves, and many combinations of different methods were employed, the object appearing to be always to prevent waste of valuable materials and skilled labor in erecting temporary and auxiliary works.

A study of these ingenious contrivances not only gives us an insight into the conditions under which Roman builders labored, but must increase our respect and admiration for their engineering and constructional ability.

Study of the ruins of Roman work indicates that the methods here described arrived at their greatest perfection during the first two centuries of the Christian era, gradually falling into disuse and disappearing in the fifth century, after which few buildings of magnitude were erected in Rome until the days of the Renaissance, when the old Roman methods had been long forgotten, only to be investigated and comprehended in these latter days of the nineteenth century.

DISCUSSION.

President Molera.—When lime mortar is buried for a year or two in pits, it is supposed to absorb carbonic acid from the air, thus tending to return to its previous state of lime rock. The reaction takes place in the mortar itself. I suppose that in these large pits the covering was not such that it was hermetically sealed against the air, and that the air inserted itself into the mass. An analysis of the mortar in the ancient work of the Romans shows there is a great deal of carbonic acid in it.

Q.—Mr. Percy, as you have described the mortar with stones put in it, is it not something like our concrete? Do you know whether our modern concrete was known to the ancient Romans and used by them?

Mr. Percy.—I think not. I think the method described by the writer I have quoted from so liberally must have been the one employed. If the materials were mixed together and put in as we put in concrete now, there certainly would not be any well-defined layers. He says that in large work it is in layers eight, nine, or ten inches thick. Evidently the mortar was first put in and the stone was then rammed down into it, bringing the mortar to the top. The most common class of work is with brick facing. If the mortar had been poured in in a semi-liquid state, the layers would not be so well defined. It is self-evident that the small stones or fragments of pottery were put in by hand, for they are always placed in a horizontal position. If they had been poured in, they would be in all positions. Then, again, in these layers there is always mortar at the bottom, growing less as it comes upward in the course. The whole thing is logical when we consider that, in building a wall, common square bricks would not make a very good bond, but in such masonry the rubble filling with triangular brick facings makes an excellent bond. There could not be a better bond devised than the triangular brick. This also would be an economical way of building walls, for it could be done with unskilled labor. It is very evident that the Romans had abundance of labor. They had great numbers of captives, and even their soldiers were put to work on these buildings and great structures. All sorts of labor were employed. It is apparent that this method was adopted so that a great amount of unskilled labor could be used in doing the greater part of the work, using skilled labor only for

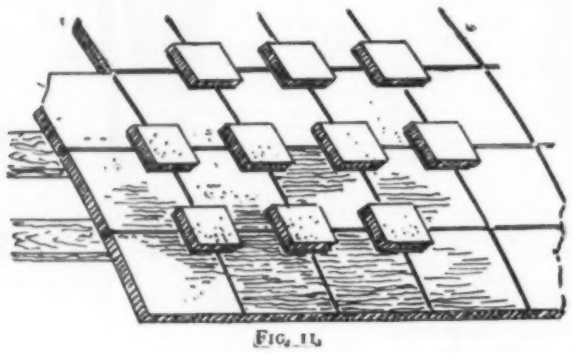


FIG. 11.

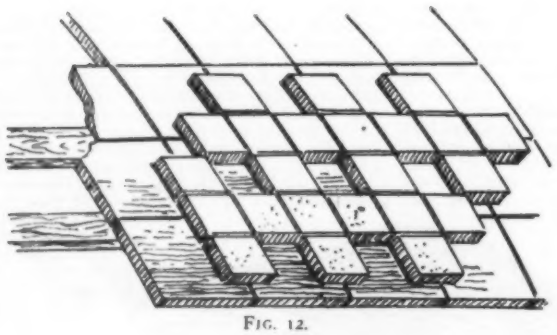


FIG. 12.

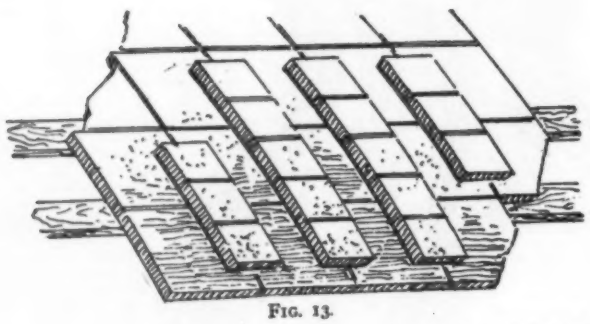


FIG. 13.

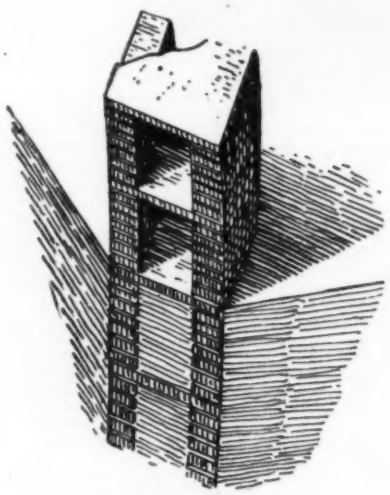


FIG. 14.

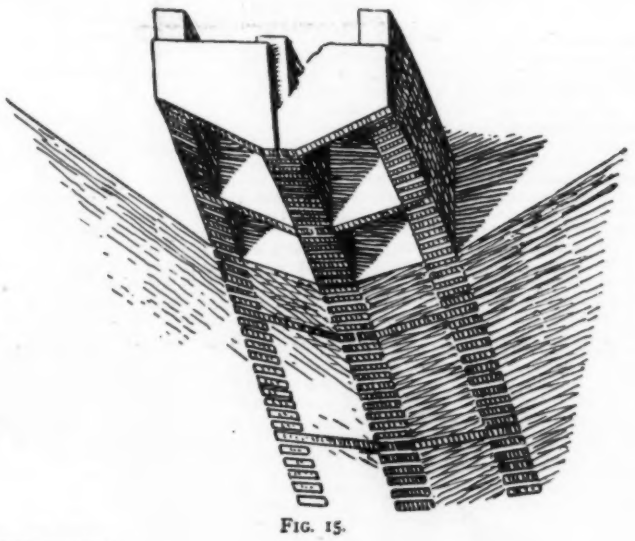


FIG. 15.

ROMAN CONSTRUCTION.

* Read before the Association of Engineering Societies and published in the Journal of the Society.

the finishing touches and the ornamentation. The ornamentation is of a Greek type, although the construction is Roman. They brought Greek architects and Greek workmen to Rome to do this class of work. With this outside finish and ornamentation stripped off we now see the real Roman work and construction.

Q.—Do you understand this construction would apply to such buildings as the Colosseum and the great aqueduct?

Mr. Percy.—Yes, the Colosseum is of this method of construction, and of cut stone. The outer wall, and the second series of arches, and a good part of the third series, are of massive cut stone, but the interior parts are almost entirely of bricks and of small fragments of stone and mortar. Perhaps it would be proper to call it rubble work; evidently the mortar and stone were put in by hand. It looks something like concrete, and it may be properly called a fine rubble. The cut stone is travertine. Some of the piers and arches of the aqueducts are of cut stone. The piers and arches of the largest aqueduct in Nero's time, for instance, were of brick and rubble. A very interesting thing about it is that some of the arches proved too weak to carry the weight, and they have been reinforced by other arches built inside of them, and the piers have been thickened. The inner arches were built entirely of brick. A few inches were left between the crown of the new arch and the under surface of the old arch, and then on one side of the wall this place was bricked up, and this mixture of stone and bricks and mortar was rammed in from the outside into all the space between the two arches, thereby strengthening the original arches.

The Roman brickwork is generally made of thin bricks, often not over an inch in thickness. It is a very common thing to find the joints as thick as the bricks are. The mortar between the bricks has coarse sand in it. This is not intended to be seen, but to be covered up by the hydraulic cement I have spoken of, which also keeps the water from penetrating.

All the great arches, including the triumphal arches, were built of cut stone, and not of concrete and brick; also most of their gateways. The oldest Roman work is entirely of cut stone, and no mortar was used. The stones were fitted very closely together. About the time of Christ, roughly speaking, this method of using triangular bricks became the common method, and is particularly shown in those monuments built in the first, second, and third centuries of the Christian era.

The Romans at first used a volcanic tufa quarried on the site of Rome. It is not very enduring and not very hard. All walls that were exposed were covered with stucco, both for appearance, I suppose, and preservation. As the Romans became more powerful, they wanted to build more enduring buildings, and they went to the foothills and mountains beyond, twenty-five or thirty miles, where there are excellent quarries of stone. You have a sample of this stone here in Golden Gate Park in the Keyes monument. That is Roman travertine. It is a very hard, enduring limestone. The Colosseum and St. Peter's are built of that material. It was used very generally for building purposes. Temple building, up to the time of Christ, or soon after—such temples as the Temple of Saturn—are all built of white marble. In the first three centuries of the Christian era the Romans were not satisfied to use white marble, and they brought the richest and finest varieties of marble that could be found anywhere in Africa or Asia. The most of this marble has now disappeared, but fragments are still found.

The stone dug out of the catacombs was a soft tufa. I do not think any of the cut stone came from there, or that it would be practicable to quarry stone out of such narrow passages. The Romans probably made use of the tufa taken out of the catacombs, but they could not have quarried building blocks of stone out of passages four and eight feet high and extending for miles in all directions. No sane man would take that method of quarrying stone, and certainly the Romans were logical people, as we have seen in the construction of their buildings. The catacombs, I believe, were made solely for burial places. The stone taken out is inferior material, at best, for building purposes. We find in this concrete or rubble work something of a guide to the age in which it was used. In the earliest work the tufa is the most common material in the concrete or rubble work. In a later period we find the travertine, and, still later, fragments of all kinds of marble, of chippings of marble, and of basalt and other stone, showing that the chippings from the stone they used for facing their temples all went into their concrete or rubble work, and nothing was lost or wasted.

I do not know of any granite near Rome, and yet we find granite used there in modern times. The church of St. Paul was burned in 1828 and has been rebuilt. There are a great number of very large columns, and they are of polished gray granite. Everything else is marble, but the columns are of granite. Where the granite came from I do not know. We find here the architectural works of the Greeks. They not only rubbed the joints of stone together to a perfect joint, but even polished the joints. I do not believe there ever was such a waste of labor anywhere in the world as that. Unless I saw it I could hardly believe that such things were done.

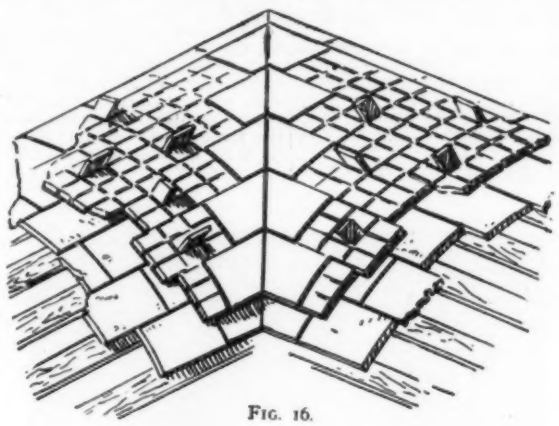


FIG. 16.

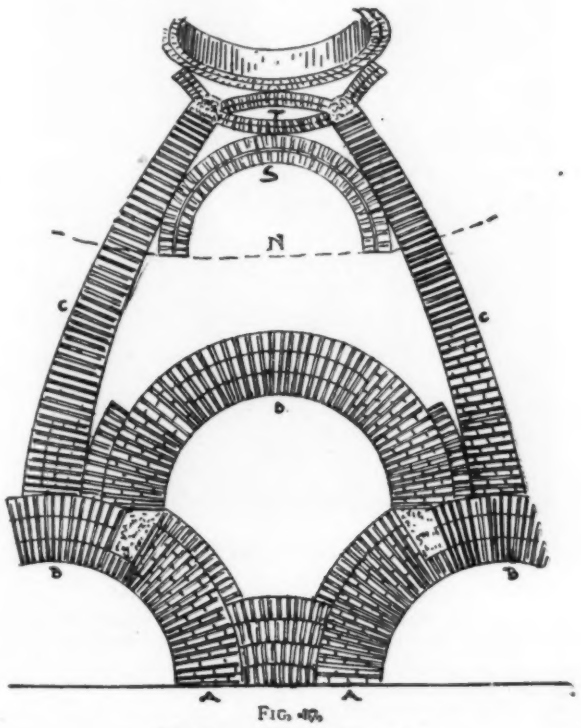


FIG. 17.

ROMAN CONSTRUCTION.

Shipping statistics recently published for the past year show that the merchant marine of the United States on June 30 last comprised 22,705 vessels of all kinds, aggregating 4,749,788 gross tons: while on June 30, 1897, it comprised 22,633 vessels of 4,769,020 tons.

ART IN PREHISTORIC TIMES.*

By THOMAS WILSON, United States National Museum.

MANY volumes have been written on the History of Art, the Origin of Art, the Dawn of Art, the Beginning of Art, the Evolution of Art, the last one, just appeared, on What Is Art? Some of these have been large, heavy works of two volumes, attempting to cover the world in their investigations and treating of art in every style and in every nation. All of these, with a single exception, begin with historic art, like Chaldean, Assyrian, or Egyptian, practically ignoring prehistoric art. I have sought to remedy this in a new work now going through the press entitled Art in Prehistoric Times. Its entire field lies in the prehistoric, and is earlier than any of the works mentioned, indeed, mine ends where they begin. Before we proceed let us consider the question posed by Tolstoi, "What Is Art?" But first let us say what it is not. It is not necessarily to be measured by the beauty of its works nor the amount of pleasure they give the beholder or listener. Indeed, it may be the reverse. A work of art may derive its principal value from the amount of awe and fear it produces. Wiertz was an excellent painter, but his gallery at Brussels is little better than a chamber of horrors. Shakespeare's tragedies rendered by accomplished actors excite emotions of horror and dread. The master musician sometimes extorts the warmest plaudits by playing a scale or number purposely false, thereby showing his art by his power over his voice or instrument.

Darwin, Spencer, Schiller, and others have defined art, but in nearly all there is something faulty in their definitions. Veron says art is the manifestation of human emotion externally interpreted by expressive arrangements of line, form, or color, or by a series of gestures, sounds, or words, governed by particular rhythmical cadences. To this Tolstoi adds the condition that the second party, the beholder or listener, must be the recipient of these emotions. This definition would revive the ancient discussion as to what is sound? Wherein it was agreed that making waves of air was necessary, but suppose, as in the case of a tree falling in the distant wood, there was no one to hear it. Certainly it would be sound, whether heard or not. So the other would be art even without a beholder or listener.

Emotions, whether grave or gay, are interpreted or manifested in some of the following methods: when by color, the art is painting; when by line, it is drawing or engraving; when by form, it is sculpture, and a combination of these may produce architecture. When the emotion is manifested by gesture or human rhythmic movements, it produces the dance; when by rhythmic notes, music; when by rhythmic words, poetry. Certain of the arts appeal to the brain through the organs of sight: painting, sculpture, engraving, architecture, and the dance; while certain others appeal through the organ of hearing: poetry, music, and the drama. In the former group action is arrested and the representation is confined to a single moment of time; in the latter group the action is continuous. But the laws as to art govern both groups alike.

A work of art is the ideal of the artist. It is his own thought or idea, is a part of himself, not nature as it actually is, but as he sees it, as he idealizes and depicts it.

The great, if not the principal, difference in the ability of artists or authors lies in the difference in their ideals, which is only another name for their taste. Taste is born with the individual and to a large extent is involuntary. True, it can be practiced and improved, and by want of thought or use it may deteriorate. But with all this it has its limits. One who cannot naturally and easily detect concords and discords of sound can never become a good musician, and he who cannot recognize harmonies of color will never become a great painter.

Despite all arguments favoring the evolution of man as a species, we must recognize that ever since man has been known on earth he has had all the powers and capacities of man, and along with them, the taste and ideality needed for an artist. So soon as he came to know art, to have a taste and an ideal, he seems to have had a desire for art objects. A desire to have them appears to have been equivalent to a desire to produce them, and so man began to make art works in times of high antiquity. Art seems to have been the germ of civilization rather than to have been its flower or fruit. This is not a priori theory, for investigating the facts and interrogating his former habitude with pick and shovel, we find that he actually made and had many pieces of considerable beauty, even if of no value, purely for ornament and, consequently, to gratify his artistic taste and give him pleasure.

This puts him on the level with modern man and ascribes to him the same motives and tastes that influence modern man to do his art work.

These manifestations of æsthetic art began in the earliest known period of man's civilization on earth, the Paleolithic. Whatever differences there may be among prehistoric archæologists as to details, they agree in the most important fact, i. e., that the human occupation of the earth is to be traced to the quaternary geologic period. It is not to be measured in years nor by any of our time units. It is simply to be described as a prior geologic period. The human race was then in its infancy. The man of that time was a savage. He did not bury his dead, he built no houses. He erected no monuments, he was a hunter and fisher, he was a nomad, had no local habitation, dwelt in no villages except such as could be so called from a number of people living in a cavern for shelter.

He had no tribal organization, no sociology, no belief in a future state, and consequently no religion. At least, no evidences of any of these things have ever been found associated with his remains, while they have been found among his successors.

Yet this man occupies, in the Solutréen epoch, the highest rank as a flint chipper, and in the succeeding, the Madelanien epoch, a correspondingly high rank as an engraver on bone and ivory.

His material (in the latter epoch) was the bones, horns, and tusks of the animals which were his prey. His tools were sharply chipped points or gravers of flint. Most of the specimens of his art work are found

* Read before the American Association for the Advancement of Science, at its meeting in the city of Boston, in August last.

in the caverns which had been his habitations. No one has sufficient knowledge to justify the declaration that this art work belongs exclusively to western Europe, but certain it is that most known specimens have been found there. They are chiefly from the caverns of central and southern France. About four hundred such specimens have been found and preserved, yet no one can know how many have been missed or remain undiscovered. The specimens found in caverns were originally thrown aside, lost in the debris, and finally protected by stalagmitic or other process of induration. They are usually enveloped in blocks or slabs, which, by infiltration, have become hard and must be quarried like stone. In bringing these to light in modern investigations, many specimens must necessarily be broken, while those in the interior of the block or slab are never discovered.

A few specimens of the art work of the Paleolithic period are purely decorative, but most of them are representations of the animals of the period and locality. Many animals now extinct are represented, and in this way knowledge of their form and appearance has been preserved to us.

The animals most frequently engraved were the mammoth, cave bear, Irish elk, musk ox, reindeer, chamois, mountain goat, urus or auroch, horse, deer, and similar animals, and finally man. Marine animals were well represented: the seal, sea lion, tortoise, turtle, fishes, and serpents. Some of the objects thus treated were utilitarian. Batons de commandement, poniard or dagger handles, harpoons and similar objects, while others were purely ornamental, only toys, playthings. Many were so broken as to destroy all clew to their purpose. This was the art of the Paleolithic period.

That of the succeeding—the Neolithic and Bronze—ages (of Europe) was quite a different style. It was almost entirely decorative, marked or cut on pottery and bronze objects of utility. There was little or no attempt to represent living or material objects. The art of these periods (still in Europe) consisted mostly in geometric forms, as lozenges, chevrons, herring bones, zigzags and cross-hatch. The Swastika seems to have been used throughout the latter period, and to have been the earliest symbol in use among men.

The North American Indian and his congeners of the Antilles were also in the Neolithic or polished stone age of culture, and their decorative art was practically the same as that age in Europe. They excelled their European brethren, however, in making rude drawings and pictures, principally petroglyphs, many of them, possibly ideographs, telling a story by their own description. They often reproduced the human figure, while the European rarely did. The aborigines of Mexico, the central and northwestern part of South America, although still in the stone age, reached a higher civilization, mainly manifested by the erection of extensive and magnificent temples, fine stone sculpturing, and ideographic language.

In closing, we are tempted to inquire why did the savage man take upon himself the additional labor of making, constructing, erecting all these, to him, a savage, unnecessary works and objects? The answer suggested is because he desired to have them; they gratified him, they gave him pleasure; they satisfied his æsthetic taste for beautiful things, and to obtain the required gratification he was willing to undergo the necessary labor and to endure the necessary fatigue. In respect of the desire for art and art works, things beautiful, wherein is the difference between the prehistoric savage who dwelt in caverns and his modern brother who dwells in a palace?

DR. WILLIAM R. BROOKS, M.A., F.R.A.S.

DR. WILLIAM R. BROOKS, director of the Smith Observatory, Geneva, N. Y., who has just reached "his majority" in cometary discovery, having recently discovered his twenty-first comet, has been a life-long student of the heavens.

He constructed his first telescope when fourteen years of age. It was of small aperture and about three feet in length, but it was twice as powerful as Galileo's telescope with which he made his marvelous discoveries. The tube of the Brooks telescope was square, as was also the sliding eye tube. He had it finished just in time to view Donati's famous comet of 1858, and this, with other wonders of the heavens which this small instrument revealed, charmed and filled with wonder our young astronomer.

When only seventeen years of age he delivered his first astronomical lecture, illustrated with charts of his own painting. It was delivered in his father's church, his father being a Baptist minister.

Later in life a larger refracting telescope was constructed with his own hands, and with which many valuable observations were made. This was followed by a reflecting telescope of five inches aperture, and with which he discovered his first comet on October 4, 1881, independently with Denning, of England, the same morning.

The following year Dr. Brooks made a still more powerful telescope, a reflector of nine and one-fourth inches aperture. It was of great excellence, as its record proves, for with this telescope twelve of his twenty-one comets were discovered.

He spent all the spare time of one year grinding and polishing the speculum and lenses of this instrument.

He had this telescope finished in time to observe the great comet of 1882, and discovered in connection therewith a fragmentary or companion comet to the great comet.

In 1883 Dr. Brooks discovered the only comets found that year, two in number. The latter of these, found on the evening of September 1, after nearly one hundred hours of patient searching with the telescope the previous month, proved to be one of the most valuable discoveries, viz., the return of the celebrated comet of 1812, and now known as the Pons-Brooks comet. It is one of the few long period comets, having a rotation period about the sun of seventy-one years four months and ten days.

Dr. Brooks discovered two more comets in the latter part of 1885 and three more in the early part of 1886. This was an unprecedented record of discovery, and stands unequaled at the present time, being five comets in a period of nine months, four comets in succession, three of these within one month and two of them within four days.

In 1887 two more comets were found by this astronomer, one on January 22, the other on August 25. The latter rivaled in interest the Pons-Brooks comet, for it was the return of the Olbers comet of 1815, and is now known as the Olbers-Brooks comet.

Thus it was with this home-made telescope that two of the three known comets of long period were observed, of which Halley's splendid comet, of seventy-six year period, stands first.

All these discoveries were made at the Red House Observatory, Phelps, N. Y.

On April 17, 1888, Dr. Brooks removed to Geneva, N. Y., upon Seneca Lake, to take charge of the new Smith Observatory, founded by William Smith, Esq. The residence of the astronomer was built first, so that he could superintend the erection of the observatory and the installation of its instruments, which are all of the highest class.

While awaiting the completion of the observatory, he erected his reflecting telescope (which he brought with him from the Red House) in the garden of his Geneva home, and discovered two comets therewith before entering the new observatory.

His first Geneva comet, from the garden observatory, was found on the evening of August 7, 1888.

Since entering the Smith Observatory Dr. Brooks has discovered eight additional comets, many of which are of great scientific interest.

The comet discovered by him on the morning of July 6, 1889, is not only a comet of short period, but stands unique in telescopic comets in being attended by four companion comets.

It returned to view again in 1896. It is known as the Brooks periodic multiple comet of 1889. For this discovery Dr. Brooks received the first medal awarded by the Astronomical Society of the Pacific.

His latest comet, No. 21, and visible at this writing, brings the sixth medal awarded to him by this society.

The Smith Observatory is fitted with first-class instruments, consisting of an equatorial refractor of ten and one-eighth inches aperture, with a photographic lens of the same size.

This telescope is furnished with all needed accessories, including a micrometer and fine spectroscope.

In the transit room is a fine meridian circle and self-winding astronomical clock.

Dr. Brooks' work is by no means confined to cometary research. Planetary and solar phenomena, double stars, the moon, charting of the nebulæ, and star clusters, all these engage his attention. Considerable time is also given to astronomical photography, in which he was an early worker.

Besides all this, large numbers of visitors are entertained with views of celestial objects through the telescope.

Illustrated lectures upon his favorite theme are frequently given to the public and the schools.

Dr. Brooks has been the recipient of many honors and prizes in recognition of his astronomical discoveries. Besides the six medals from the Astronomical Society of the Pacific, he has won over $1,000 of the Warner gold prizes for cometary discovery.

In 1886 he was elected a fellow of the American Association for the Advancement of Science. A rule of the Association requires that a person be a member at least one year before he is eligible to a fellowship. But the council voted to suspend this rule, and made him a fellow on his election to membership—an honor all the more notable because it was the first instance of the kind in the history of the Association.

In 1888 Dr. Brooks was made a fellow of the Royal Astronomical Society, and in 1890 was elected a member of the British Astronomical Association. In 1891 Hobart College conferred upon him the degree of Master of Arts, and later elected him to honorary membership in the Phi Beta Kappa Society.

At its commencement in 1898 Hamilton College conferred upon him the degree of Doctor of Science.

DR. WILLIAM R. BROOKS, M.A., F.R.A.S.

THE IMPORTATION OF GOLD.

THE importations of gold into the United States in the year 1898 are by far the largest in the history of the country, and the exportations the smallest in many years, while the production of gold from our own mines will prove the largest in many years, if not the largest in the history of the country. The October statement of imports and exports, just issued by the Treasury Bureau of Statistics, shows that the total imports of gold in the ten months ending October 31, 1898, are $143,658,095, which is more than 50 per cent. in excess of the amount imported in the corresponding period of any preceding year. The exports during that time have been but $14,061,849, which is less than in the corresponding months of any preceding year for more than a decade. This gives the enormous balance of $129,596,246 of gold importations in excess of gold exportations. In only one other year in the decade have the ten months ending with October shown an excess of imports of gold over the exports, that occasion being in 1896, when the excess of imports was $37,085,861. In all other years from 1888 to 1898 the October returns showed for the ten months of the calendar year an excess of exports of gold over the imports of that article, that of 1895 being $43,247,360 and 1894 $72,808,322.

This unprecedented flow of gold into the United States is accounted for in part at least by the enormous balance of trade in our favor which the ten months of the year afford. In those ten months the total imports of merchandise amounted to but $527,757,554, while the total exports were $987,964,356, a balance of trade in our favor of $460,206,802. The total exports of merchandise for the month of October, 1898, amounted to $118,686,232, a sum larger than in any preceding October in the history of the country; the figures for October, 1897, being $111,744,517, and those for October, 1896, $113,516,586.

The following table shows the imports and exports of gold in ten months of the calendar year, in each year since 1888, also the excess of imports or exports:

Ten Months Ending October 31.	Gold Imports.	Gold Exports.	Excess of Imports.	Excess of Exports.
1888	$8,093,426	$21,424,834	.....	$13,331,408
1889	8,926,018	50,044,798	.....	41,118,783
1890	12,270,276	22,863,568	.....	10,593,292
1891	30,079,542	78,450,131	.....	48,370,589
1892	13,333,196	62,513,682	.....	49,180,486
1893	67,544,569	76,789,532	.....	9,244,963
1894	18,935,513	91,743,835	.....	72,808,322
1895	32,157,170	75,404,642	.....	43,247,532
1896	94,442,915	57,357,054	$37,085,861	.....
1897	98,784,098	32,998,992	.....	4,614,794
1898	143,658,095	14,061,849	129,596,246	.....

The enormous importation of gold in excess of the exportation of this article is plainly perceptible in the increased circulation shown by the figures of the Treasury Department. The latest statement of the gold in the Treasury shows a gold balance of $242,805,604, while the gold in circulation on November 1 was $649,846,727, being $110,000,000 greater than on November 1 of last year, and nearly $200,000,000 more than on July 1, 1896, in which month it touched its lowest point in several years.

The total money in circulation at the beginning of the present month is shown by the Treasury figures to have been $1,866,575,782, against $1,706,732,904 at the corresponding date last year, and $1,509,725,200 on July 1, 1896, the increase in circulation in the past year having been $159,842,878, and since July 1, 1896, $356,850,582.

ENGINEERING NOTES.

There were 2,639½ miles of railways open for traffic in New South Wales at the end of last year, and the number of train miles run was 2,187,760, or an increase of 12,306 miles. The earnings were 8s. 2½d. and the expenditure 3s. 10½d. per train mile, a percentage of 47·37. In goods traffic the mileage shows a decrease of 52,700.

The famous Gravity road, owned by the Delaware and Hudson Company, and which has been operated, we believe, since 1829, is to be abandoned, together with the canal in connection with which it has been operated. The management finds that it can ship its coal by steam railway cheaper. Arrangement for handling this coal traffic has been made with the Erie. The change will seriously affect the towns of Honesdale and Carbondale, and will take from the traveling public one of its famous novelties—a ride over the Gravity road.

The investigation of the Cornwall bridge failure on September 6, in which two spans of the new New York and Ottawa Railroad bridge across the St. Lawrence River, at Cornwall, Ont., were precipitated into the water by the failure of the masonry pier between them (Eng. News, September 15, 1898), has disclosed the cause of the accident, according to press dispatches. The diamond drill borings which are being made into the foundation bed of the collapsed pier have shown that the pier was founded on a bed of hard pan barely 2 feet thick, below which was a muddy deposit into which the drill sank 14 feet without striking hard bottom. Further borings are being made to determine the conditions more exactly.

The steamship "Milwaukee" ran on the rocks near the mouth of the Tyne in September last, while on a voyage from South Shields to New Orleans. The after part of the vessel was afloat in deep water, and it seemed an easy job to haul her off, but it was found that her bottom had been pierced forward of the bridge, and that for a length of thirty feet the rock penetrated eight feet into the hold. It being impossible to float the vessel whole, the forward part was slowly blasted off with dynamite. The bulkhead forward of the coal bunkers was strengthened, and after a month's work the aft two-thirds of the "Milwaukee," containing the engines, was floated and towed into port. A new fore part will be built on.

An American line, the New York, Chicago, and St. Louis, has found that considerable saving can be made over the present methods of painting and lettering locomotives and tenders, says The Engineer. This road now paints the tenders with asphaltum applied with a broad brush, while the letters and numbers, instead of being made on the tenders and locomotives themselves, are painted on wooden sign boards, which are held in place by bolts. In this way all the lettering can be done in the paint shop, while the engine and tender are undergoing repairs, so that the locomotive is not kept out of service several days while being lettered. It is stated that in this way the painting costs between $30 and $35 less for each locomotive than it did formerly.

For many years steam jets have been considered excellent means for extinguishing fires in inclosed spaces, and examples of their good services have been abundant. The theory of their action, of course, is, like that of the several kinds of fire extinguishing powders which have been proposed at different times, that the steam in the one case and the stifling fumes from the powders in the other displace the air in any particular space under consideration, and with it the oxygen as well, by which alone combustion can be sustained, says Cassier's Magazine. In at least one instance, however, the position was taken that, if the steam jets did not extinguish a fire promptly, they soon became a source of danger, and as such were held accountable for the loss about a year ago of a cargo steamer carrying several hundred tons of coal and as many more of miscellaneous chemicals and old rope. Fire broke out in one of the holds, which were fitted with steam jet fixtures, and the jets were at once turned on. On the day following it was proposed to try a hose in addition to the jets, and one of the upper deck hatches was therefore taken off. The almost immediate result was a violent explosion, killing one of the officers and seriously injuring another. All the other hatches were blown off at the same time and the ship began to leak, so that she soon had to be abandoned. One explanation advanced was that the steam from the jets, passing over the incandescent cargo, formed water gas, which, with suitable air admixture, became explosive, with the result noted.

Some interesting particulars of the water power available in Ontario are given in an article on the subject by Mr. T. W. Gibson in the third part of vol. vii. of the Report of the Bureau of Mines just to hand. The author states that if Mr. Tesla's conclusion be correct, namely, that a waterfall affords us the most advantageous means of getting power from the sun for all our wants, excelling for this purpose not only muscular force, but wind and steam as well, the rocky uplands of Northern and Western Ontario may yet be reckoned among the most valuable parts of the province by reason of the vast number of waterfalls situated there. The main watershed dividing the system of the great lakes from that of Hudson Bay runs in a northwesterly direction from the eastern boundary of the province north of Lake Temiscamingue to the head of Lake St. Joseph on the northern boundary a distance of about 500 miles. It consists of a tableland or plateau rather than a sharply defined ridge, and is estimated to have an average width of about 70 miles, or an area of about 35,000 square miles, thus with the slopes on both sides affording an extensive catchment surface for streams running to the north and south. Its elevation will average perhaps 1,400 feet or 1,500 feet above the level of the sea, or 900 feet above Lakes Huron and Superior. In places it approaches the shore of the latter lake, and for the greater part of its extent is situated at a comparatively short distance from either of these bodies of water. The consequence is, that the rivers and streams which flow from it into the great lakes, though mostly of considerable volume, are not of great length, and their descent is therefore usually rapid and abrupt, and marked in many places by cascades and falls.

MISCELLANEOUS NOTES.

The population of the globe, according to M. P. D'Amfreville, is about 1,480,000,000, distributed as follows: Asia, with 825,954,000; Europe, with 357,379,000; Africa, with 163,933,000; America, with 121,713,000; Oceanica, and the Polar regions, with 7,500,400; Australia, with 3,230,000; or a grand total of 1,479,729,000 souls. It is stated that of every 1,000 inhabitants of the globe, 558 live in Asia, 242 in Europe, 111 in Africa, 83 in America, 5 in Oceanica and the Polar regions, and only 2 in Australia. Asia thus contains more than one-half of the total population of the earth, and Europe nearly one-fourth.

The platinum production of Russia, according to Mr. W. R. Holloway, United States Consul-General at St. Petersburg, for the year 1897, was over 95 per cent. of the entire amount mined in the world, or about 6 tons. Most of this came from the following mines:

Mines of Count P. P. Shuvaloff	1 ton	396 lb.
" Count Demidov San Donato.	1 ton	144 "
" J. Burdakov & Sons	?	1,512 "
" Kolly		1,404 "
" Andreieff heirs		1,188 "
" Koenigsberger		1,008 "
" P. A. Konukhoff		792 "
" nineteen small proprietors		1,620 "

About two years ago experiments were commenced in Germany in the manufacture of briquettes from peat or turf. Consul Kehl says that the adventure is meeting with success, and in a report to the Department of State describes the process of manufacture. After the turf has been cut it is brought, in a wet condition, to a breaking machine, which reduces it to small pieces, whence it passes to a second machine, where it is cut and ground quite fine. The turf is then dried by passing through a large cylinder filled with exhaust steam from the engine. The inside of the cylinder is filled with large tubes, after the style of a boiler, resting at an angle and continually revolving. This permits the mull to pass through perfectly dry. From here it is carried to the hopper which feeds the press. The press which forms the briquettes is operated by a 75 horse power engine, and finishes one briquette with each stroke. The capacity at present is about 80 briquettes a minute, or 35 tons a day. The cost of material and working one ton of briquettes at Langenberg, where one of the plants is located, is estimated at about $1.35. Coal briquettes retail at $3.75 per ton.

Dr. Ludwig Mond has devised an ingenious process for extracting nickel from its ores, by combining the metal with carbon monoxide. The process is of exceptional interest because nickel is a very refractory metal, having a melting point of over 1000° C., and is yet able to combine with carbon monoxide at a temperature of over 50° C. to form a gaseous compound —nickel carbonyl That gas, on heating to a temperature of 150° C., becomes completely dissociated, pure carbon monoxide being given off and metallic nickel deposited on the sides of the vessel in which the gas is heated. Nickel ores, most of which contain sulphur and arsenic, are first roasted to convert them as far as possible into oxides, and the resulting oxides are treated with reducing gases so as to reduce the oxides to finely divided metallic nickel. The reduced nickel is then transferred to a suitable tower, which is maintained at a temperature not exceeding 100° C., and carbon monoxide passed over the material. The nickel carbonyl thus formed is then passed into a suitable chamber or vessel containing granules of commercial nickel or iron, and on being heated to 180° C. the nickel carbonyl is immediately decomposed, and metallic nickel deposited on the granules of metal, while carbon monoxide is set free. The carbon monoxide thus liberated in the process is returned to the volatilizer, where it attacks a fresh quantity of nickel, so that the process is continuous.—Pharmaceutical Journal.

Exports of manufactured goods from the United States, and their phenomenal growth in the past ten years, as compared with the two preceding decades, are well shown by a table just issued by the Bureau of Statistics of the Treasury Department, which we reproduce as follows:

Total value of exports for fiscal year ending June 30.
(Note that 1 = 1,000.)

Manufactures.	1868.	1878.	1888.	1898.
Iron and steel	$8,352	$16,052	$17,763	$70,367
Refined mineral oils	20,020	43,594	41,290	51,782
Copper and mfrs. of	479	2,329	3,812	32,180
Leather	1,414	8,080	9,583	21,113
Cotton manufactures	2,971	11,438	13,013	17,024
Chemicals	2,757	3,414	5,633	9,441
Wood manufactures	2,088	3,963	4,733	9,098
Cycles	...	....	....	6,866
Agricultural implements	679	2,575	2,645	7,609
Paraffin	47	135	2,168	6,030
Paper and manufactrs. of	524	1,086	1,078	5,494
Tobacco manufactures	3,100	3,681	3,776	4,818
Fertilizers	35	1,308	1,255	4,359
Scientific instruments	....	27	714	2,770
Books, maps, etc	349	586	1,734	2,434
Flax, etc., manufactures	592	1,202	1,591	2,557
Sugar and molasses	348	4,920	3,255	2,111
Carriages and horse cars	404	979	1,581	1,946
Spirits	1,416	1,149	871	1,850
Oils, vegetable	186	328	281	1,843
India rubber manufact's	170	305	806	1,723
Clocks and watches	536	906	1,529	1,727
Zinc manufactures	68	216	18	1,339
Marble and stone mfrs	....	567	644	1,792
Gunpowder, etc	546	3,459	648	1,395
Stationery	....	....	425	1,005
Musical instruments	173	756	908	1,383
Glass, etc	609	869	881	1,211
Brass manufactures	16	589	308	1,259
Starch	205	605	202	1,371
Soap	636	658	815	1,390
Railway cars	....	532	826	1,478
Paints, etc	131	230	492	1,079
Wool manufactures	306	449	471	1,089

It should be especially noted that the growth in volume of exports is really much larger than the above table shows, for prices have gone steadily downward during the past thirty years. This is especially true of the decade from 1888 to 1898, in which the greatest growth in the value of exports is shown. Besides this, it must be remembered that the value of the exports of 1868 was measured in the paper currency of that date, the value of which was only 71·5 per cent. of the value of gold. Hence the growth in volume of exports from 1868 to 1878 was at least 30 per cent. more than the above table shows.

SELECTED FORMULÆ.

Preventive of Rust on Metal Work. — Lard 125, camphor 20, are melted together, and a little graphite added. The objects are dressed with this paste, which is removed after twenty-four hours.—Chemical News.

Tomato Ketchup.—Spices of various kinds are employed for this purpose, as the following formula shows:

Ripe tomatoes ..... 6 quarts.

Bruise and set in an oven with 1½ lb. of salt and a quart of water. At the end of an hour pour off a gallon of juice, and to this add—

Shallots, peeled and sliced	4	ounces.
Black pepper, bruised	½	"
Mace, bruised	½	"
Pimento, bruised	½	"
Ginger, bruised	½	"
Nutmeg, bruised	½	"
Cochineal, in coarse powder	2	drachms.
Cayenne pepper, in coarse powder	1	"
Brown vinegar	1	pint.

Simmer gently for half an hour, strain and bottle.

How to Make Charcoal.—To make charcoal readily on a small scale, place small pieces of wood in a clay crucible, cover it with wet clay, and heat in an ordinary fire for about an hour; thus all the volatile matter is driven off, and on cooling the charcoal will be found in the crucible. On the large scale charcoal is made by burning wood in large heaps or piles, covered with earth or clay, or in ovens or kilns to which only a limited supply of air is allowed access. Any kind of wood may be used, but the hard woods, such as oak, beech, and fir, produce the best and densest charcoal. Charcoal is also produced by heating wood in iron retorts, the volatile products, such as wood tar, creosote, and acetic or pyroligneous acid, being condensed in receivers and utilized.—Work.

A Green Coloring for Liquids.—Use chlorophyl, tincture of grass, or mix yellow with blue, as follows: Make an infusion of 180 grains of saffron to 8 fluid ounces of distilled water, and to it add sufficient solution of indigo-carmine until the desired shade is obtained. Another green may be made as follows:

Tincture saffron	6	fl. ounces.
Glycerin	6	"
Solution indigo-carmine	sufficient.	

Add the indigo-carmine solution gradually, with constant stirring, to the mixture of tincture and glycerin, until the desired shade is produced. If to be used immediately, the glycerin may be omitted or replaced by water.

Chlorophyl may be employed in alcoholic or aqueous solution for coloring preparations a green tint. It may be purchased or it may be prepared as follows: Digest leaves of grass, nettles, spinach, or other green herb, in warm water, until soft; pour off the water, and crush the herb to a pulp. Boil this for a short time with a ½ per cent. solution of caustic soda, and afterward precipitate the chlorophyl by means of dilute hydrochloric acid; wash the precipitate thoroughly with water, press and dry it, and use as much for the solution as may be necessary.

Malachite green and other aniline colors have been suggested.—Pharmaceutical Era.

Witch Hazel Jelly.—A recent formula said to possess merit is the following:

WITCH HAZEL JELLY.

Gum tragacanth, in pieces	4	ounces.
Glycerin	15	"
Alcohol	20	"
Distilled extract of witch hazel	20	"

Soak the gum in 80 ounces of water for 48 hours, stirring frequently, add the rest of the ingredients, and make up to 10 pints with water; then press through cheese cloth, and perfume with otto of rose, heliotropin, or any other scent.

Put up in collapsible tubes, this makes a good selling specialty for use after shaving, and is a first class remedy for chaps, sunburns, roughness of skin, etc.—American Druggist.

Starch Gloss.—Some prefer powder gloss and others a liquid preparation.

POWDERS.

1. Powdered borax	8	ounces.
Potato starch	1	"

Directions.—Take a teaspoonful with each heaped tablespoonful of ordinary starch used.

2. Powdered spermaceti	1	ounce.
Powdered borax	1	"
Powdered starch	4	"

To be used like the preceding.

3. Powdered talcum	3	ounces.
Powdered soap	1	"

Directions.—Take a new flannel rag and dip it into the powder. Rub well over the right side of the starched article, then iron in the usual way.

LIQUID GLOSS.

1. Powdered spermaceti	1	drachm.
Powdered acacia	1	"
Powdered borax	1	"
Glycerin	2½	fluid drachms.
Water	14½	" "

Boil half of the water and add the borax and spermaceti to it. Separately dissolve the acacia in the remainder of the water and the glycerin; strain, and mix thoroughly with the warm spermaceti-borax mixture.

Directions.—Use a tablespoonful with 4 ounces—a heaped tablespoonful—of dry starch.

2. Glycerin	2	fluid drachms.
Oil turpentine	2	" "
Borax	2	drachms.
Starch	2	ounces.
Water	12	fluid ounces.

Rub down the starch with water to a smooth paste, and add the remainder of the water, in which the borax has been previously dissolved; then add the glycerin and oil of turpentine.

To be used like the preceding.—Merck's Report.

THE ANNAMITE THEATER.

THE theater of Annam, if not an exact repetition of that of China, at least takes its inspiration therefrom.

It puts upon the stage dramas, comedies and vaudevilles. According to Chinese books, a serious drama should present the noblest instruction to the ignorant who know not how to write, and, according to the code, the object of theatrical production is to exhibit upon the stage real or fancied portraitures of just and good men, chaste women and affectionate and obedient children, which may lead the spectators to the practice of virtue.

The drama generally consists of four acts, and sometimes a prologue. Intrigue proceeds up to the punishment of the crime.

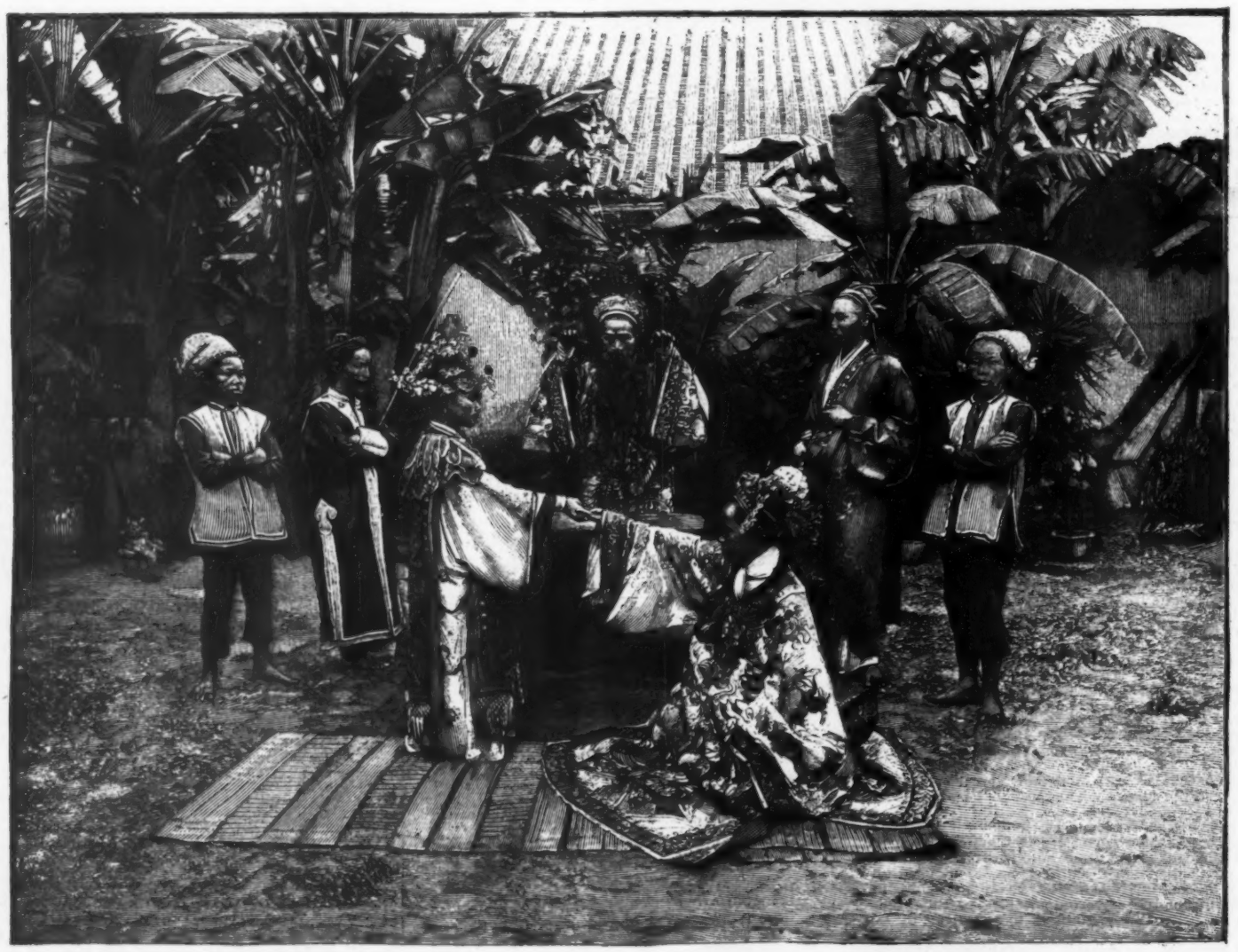
The comedy also rewards virtue, although virtue in the East is often what is considered vice in the West.

Thus, in "Tran-Bo," the virtuous person is an old man who wishes a second wife, because the first Mme. Bo is old and barren. After many discussions and the intervention of a bonze and a soothsayer, Mme. Bo consents to Tran-Bo's taking a second spouse. Much better still, she acts as a procuress and promises not to be jealous. But her bad nature soon gets the better of her, and she becomes crabbed and intercepts all relations between Tran-Bo and his young wife. The bonze and soothsayer come to demand the reward of their good offices from Mme. Bo and get into trouble. The soothsayer breaks away and makes his escape. In the succeeding acts, Tran-Bo, with the aid of a faithful valet, succeeds in rejoining his young wife. The vice of jealousy is foiled, and Tran-Bo is to have his child.

The consideration paid to the author in the success of a piece is so slight that he does not even sign it, and the spectators do not bother their heads about him at all. Dramatic compositions are sometimes capable of interesting us when read, but they lose what little relish they may have by the manner in which they are played. We know of nothing more monotonous and deafening than an Annamite representation. Eloquence therein is the art of bawling and vociferating with a fog-horn voice. In burlesque representations there are banners and sabers; the actors are daubed with paint; the mandarins and warriors are represented in ragged official costumes; the orchestra is composed of gongs, tomtoms, flutes and clappers; and the supernumeraries, scarcely ever at rest, squat at the right and left side of the stage.

The actors, who come to prostrate themselves in front of us before beginning to play, salute and curtesy every time they cross the front of the stage. The prompter runs after them, now crouching and now standing, and keeps within a stride of them. The urchins creep under the furniture or else mingle with the martial hordes that defile in shouting. Voyages are made upon the sea by an individual who pulls an oar, and upon horseback by a trotting accompanied with the cracking of a whip. Heroic deeds are cried out in a stentorian voice, and comical things are said in a low tone, combats are simulated by contortions and wheelings about in which the adversaries, terrible in

ACTORS PROSTRATING THEMSELVES BEFORE THE SPECTATORS PREVIOUS TO THE PERFORMANCE



A SCENE FROM THE PLAY ENTITLED "TRAN-BO."

THE THEATER IN ANNAM.

their war paint, saw the air with wooden weapons. The changes of scenery are effected without lowering the curtains.

The actors who are not playing quietly await their turn at the back of the stage near the orchestra, and, when the curtain remains partly open, those who are tattooing themselves may be plainly seen.

The women do not play, but form a special corps of singers who never mix with the actors. The spectacles are always gratis to the public. The actors come to play at the request of a mandarin or of a wealthy citizen who pays in the following manner. The functionary immediately beneath, or the friend of him who has bespoken the theater, places himself in front of a tomtom. Sometimes a guest of high rank places himself in front of another. Then with a blow upon the tomtom, they score all the effective passages and throw upon the stage a small string of "cash," of the value of two cents. Sometimes three strings, with accompanying blows of the tomtom, are thrown successively, and this means an encore. Two employes of the theater come upon the stage in the midst of the actors, gather up the cash and restring it, and then pass it over to the official approver in exchange for a check. At the end of the performance the checks are handed over to the director of the theater.

The pieces played in these theaters are sometimes interminable. On the occasion of certain great fetes, the play proceeds uninterruptedly for several days, and the actors, as they become exhausted, are replaced by others. For the above particulars and the engravings we are indebted to L'Illustration.

THE AUSTRO-HUNGARIAN ARMORED CRUISER KAISER KARL VI.

ON October 4, the Austro-Hungarian armored cruiser Kaiser Karl VI. was christened and launched at the yards of the well known "Stabilimento Tecnico Triestino," at San Rocco, near Trieste. This new vessel combines the most advantageous characteristics of a cruiser with fighting qualities that are nearly equal to those of a battleship, while its dimensions, its armament, and its efficiency testify to the high standing of the shipbuilders and marine engine makers of the Hapsburg monarchy.

This vessel, which is so well prepared to meet all possible problems of naval warfare, has a displacement of 6,250 tons, a length of 390 feet 2 inches, a breadth of 56 feet 5 inches, and a depth of 20 feet 4 inches. On both sides of the vessel, for half of its length, it is protected by a belt of nickel steel armor which is about 6 feet wide and 8·6 inches thick. The armor on the turrets and casemates is 9·8 inches thick, that for the bulkheads 7·8 inches, and for the protective deck 1·3 inches thick.

In each of the two barbette turrets there is a Krupp rapid-fire gun of 9·4 inches caliber and 40 calibers long, which is turned and served by electricity, and the casemates on the battery deck are provided with 5·9-inch rapid-fire guns, which are 40 calibers long and of the Skoda pattern. The artillery equipment consists of eighteen 1·8-inch rapid-fire Skoda guns and two rifle-caliber mitrailleuses, besides two 2·7-inch guns to be used in boats and on land. Two broadside tubes constitute the torpedo apparatus.

The two engines of the newest type are located under the armor deck. Together they develop 12,000 H. P., giving the vessel a speed of 20 knots an hour—a speed attained by very few vessels of this size. Electricity is used very generally as a motive agent for the numerous mechanical devices, whereby the amount of steam piping required is greatly reduced. The vessel is lighted by hundreds of incandescent lights and is provided with four search lights, each of 25,000 candle power.

In view of its armament, its protective armor, and its great speed, the Kaiser Karl VI. is a most important addition to the Austro-Hungarian navy, strengthening as it does her cruiser class.

For the above and the accompanying engravings we are indebted to the Illustrirte Zeitung.

APPLIED SCIENCE IN THE NAVY.*

AMONG the technical reports issued from the government press, just now, those coming from the departments of the government most active in the war with Spain are of special interest. That of the Chief of the Bureau of Steam Engineering of the Navy Department, Com. G. W. Melville, is now published, and, though brief and businesslike, gives some interesting information of a more or less scientific nature, as well as of a kind to interest the average citizen in a more general way.

The first effect of the demand upon the Department for preliminary work was to "demonstrate in the briefest and most vigorous manner the necessities, facilities and deficiencies" of the naval establishment. Fortunately, as it proved, the already established policy of keeping at the navy yards ample stocks of material and stores reduced enormously the risks and delays, embarrassments, and dangers of a sudden call for active service of every available ship and gun. Much was necessarily done, however, before satisfactory provision could be made for all emergencies; yet it will never be forgotten that the navy never failed when called upon.

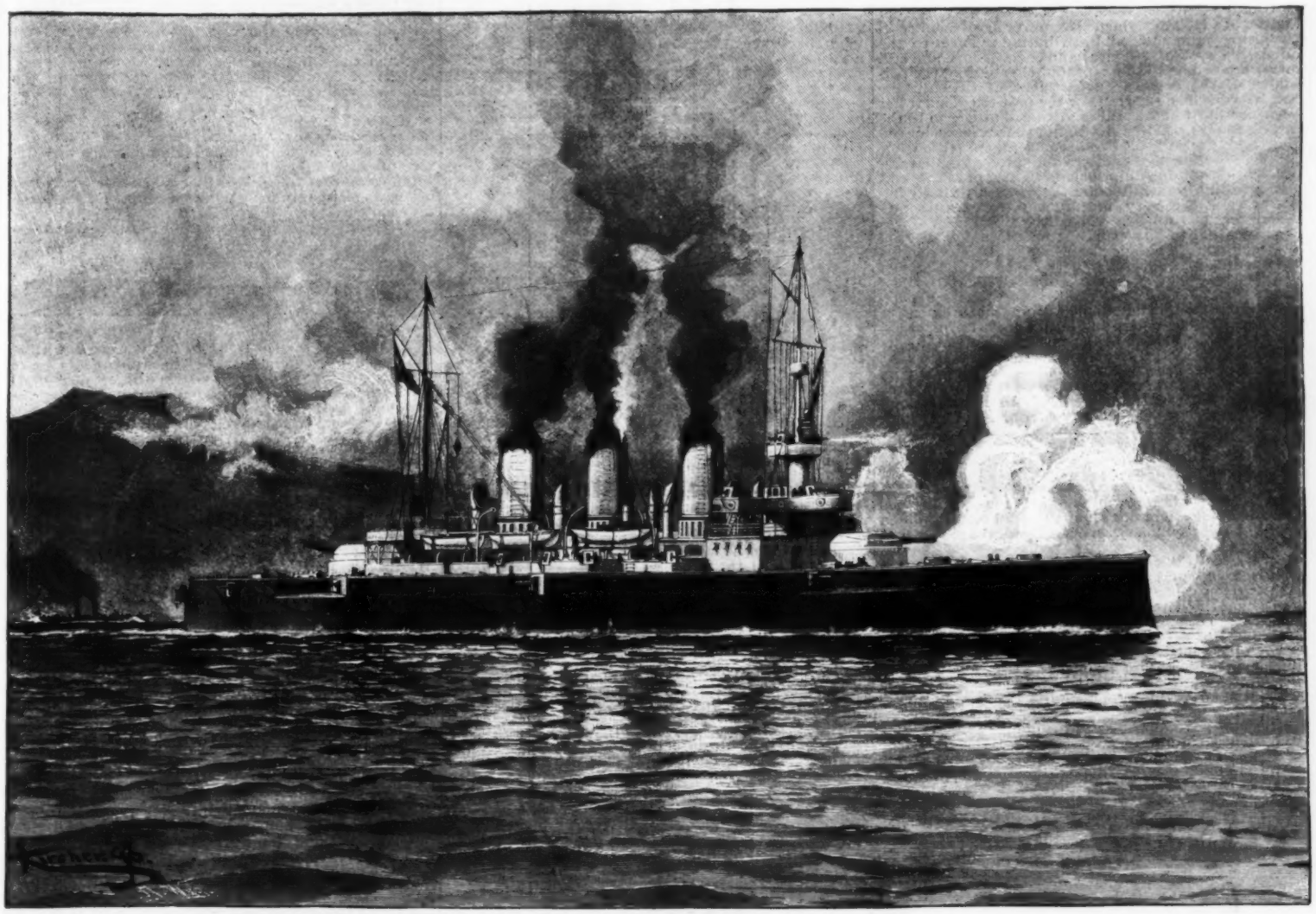
Some work was performed with marvelous dispatch. Thus, the old and worn out "shell-boilers" of the monitors "Manhattan," "Mahopac" and "Canonicus," at League Island, were replaced by new constructions in thirty days. The new water-tube boilers were passed, in parts, through the hatches and the old boilers were cut in pieces below and passed up in small sections; thus saving the time, cost, and risks of destruction and reconstruction of the decks which would have been necessary had the old types of boiler and ways of doing work been adopted. This necessity had been foreseen and provided for before the war actually began, and a provisional contract with the only firm known to be ready and able to undertake the task had been made. In five hours after the contract was signed the work had been commenced. The performance of these ships with the new boilers excelled the best work with the old.

The most tremendous work, in kind and quantity, was that of fitting out the auxiliary fleet of more than a hundred ships, of all sizes, kinds, and duties, from tugs and ferryboats to ocean steamers from the transatlantic lines. All were necessarily extensively altered to adapt them to their new duties, and the provision of stores, already alluded to, proved an essential element of success in securing their services promptly upon the outbreak of war. Even floating machine shops to make repairs in the midst of the fleets were sent out and proved of inestimable value.

"There was a remarkable absence of casualty in the machinery departments of the vessels of the fighting fleet during the war. Even in action, when forced draught conditions were in operation and the excitable natures of the men most wrought upon by the surroundings, the reports show that the machinery not only worked well generally, but that in no case was it greatly distressed. This is as fine a comment upon the personnel as upon the machinery." The statement does not apply to the torpedo boats, the condition of which, under circumstances of operation entirely unintended in their construction, "can only be described as horrible—boilers were burnt, cylinder covers broken, piston and valves stuck, everything in bad shape." This was due to absence of expert and professional supervision and to employment on duty for which these craft are not intended and for which they are unfit. No member of the Naval Engineer Corps could be spared to care for them, and the inexperienced and the inexpert young officers in charge of the boats could not be expected to succeed in keeping their machinery in order.

The amount of work performed by this Bureau, in designing new machinery, in refitting old, in construction at the navy yards, and in repairs of ships, can only be realized on reading in detail the full report. Over four millions of pounds of iron and steel passed under inspection and were shipped to points at which this material was needed. All specifications and methods of inspection and test have been revised; including physical, chemical, and mechanical methods and limitations of quality. Nickel steel has been made an important and useful material for engine construction; steel tubes are now made without weld and wonderfully perfect. New methods of shaping and welding parts give hitherto unapproachable security in use. Steel containing an unusually high proportion of carbon is now found applicable to even steam boiler construction. Tenacities exceeding 74,000 pounds per square inch are attained, with extensions rising above 21 per cent., and with elastic limits above 40,000 pounds. Such gains allow reduction of sizes and parts and, still more important, in a battleship, diminution of weights.

Water-tube boilers are unqualifiedly approved for naval purposes, and experience with those of the "Marietta," while accompanying the "Oregon" on the



THE AUSTRO-HUNGARIAN ARMORED CRUISER "KAISER KARL VI.," AFTER COMPLETION.

* From Science.

long 14,000-mile voyage around Cape Horn, proves the reliability of such boilers when properly made and handled. The experience confirms the results of test in foreign navies also. Nearly all naval vessels, at home and abroad, now include in their specifications the water-tube boiler. "The tactical importance of water-tube boilers has been emphasized by the conditions which obtained in the blockade at Santiago and the great victory of July 3. It was necessary for a long period that our ships should be ready to develop maximum power at a few minutes' notice; and with cylindrical boilers this involved keeping all the boilers under steam, with heavily banked fires and a large attendant consumption of coal. Water-tube boilers of the proper kind, which admit of the rapid raising of steam with safety, remove this difficulty and give the commanding officer a more complete command of his fighting machine." Giving great power with small weight, this modern apparatus of power production is coming into use on all torpedo boats and, as a rule, on even the heavy battleships.

The steam turbine is referred to, but with the statement that it is not yet certain that it will find permanent place in the naval service.

The use of oil fuels is pronounced promising in some naval work where costs of fuel are not of prime importance. Success is met with in the use of an oil of s. g. 0·85 to 0·87, a flash point of 315° Fah., and a burning point of 350° Fah. This oil is entirely safe on shipboard.

Referring to the marvelous performance of the "Oregon," her long voyage, perfect condition at its end, and later effective action with the squadron off Santiago, a record "which has never been equaled in the history of navies," and attributing this fact to the admirable work of designers and constructors, and still more, if possible, to the splendid character of the personnel of the engineer department of the ship, the Engineer-in-Chief says: "For the past ten years it has been my duty and a sad one to call attention to the urgent need of a reorganization of the personnel of the Engineer Corps." Its enlargement, provision for proper selection of its officers and professional training, and of suitable inducements to men of talent and genius in this branch to enter the corps, are vitally important and necessary amendments to existing provisions for its support. An efficient Engineer Corps is as essential to the efficiency of the navy as good war engines. The engineer and his war engine together make victories like those of Manila and of Santiago possible, with the no less essential aid of good "men behind the guns." The whole department is one of applied science of the most extensive and imposing character, and an Engineer Corps, scientifically educated and systematically trained to its peculiarly exacting and responsible work, is the most pressing need of the "new navy." The report, and its conclusion regarding the lessons of the war, is most instructive from both the scientific and political standpoints.

R. H. Thurston.

THE RÜSCH-SENDTNER HYDRAULIC GOVERNOR.

The new resistance or brake governor shown in the accompanying engravings is adapted for maintaining a constant velocity in any sort of a hydraulic motor that may require it.

Apparatus of this kind usually consist of a pump that forces a liquid through the seat of a valve which is lifted by a centrifugal governor. According to the position of the latter, and consequently of the valve, the pressure or energy absorbed by the pump increases or diminishes.

The objection has been made to regulators of this kind that they require frequent repairs. Their slow running requires also the use of heavy and very taut belts that develop strong pressures in the pillow blocks.

The new governor that we are about to describe is free from such objections. It utilizes the excess of energy due to a diminution of the power employed for setting in motion a certain quantity of liquid, and thus creates a mechanical resistance, the extent of which varies directly with the velocity of the motor on which it is used. Such mechanical resistance is developed by a wheel, *F* (Fig. 1), provided with paddles, *S*, upon its circumference and revolving in a drum, *K*, through the intermedium of a belt running over the wheel, *P*, and connected with the motor or machine to be regulated. The drum is put in communication with the pipe, *L*, of a water reservoir by the box, *W*, of the valve, *V*, which is connected with the coupling box of a ball governor, *T*, actuated by the motor through the pulley, *p*.

At the upper part of the drum there is a channel that communicates with a waste pipe, *O*, through which the

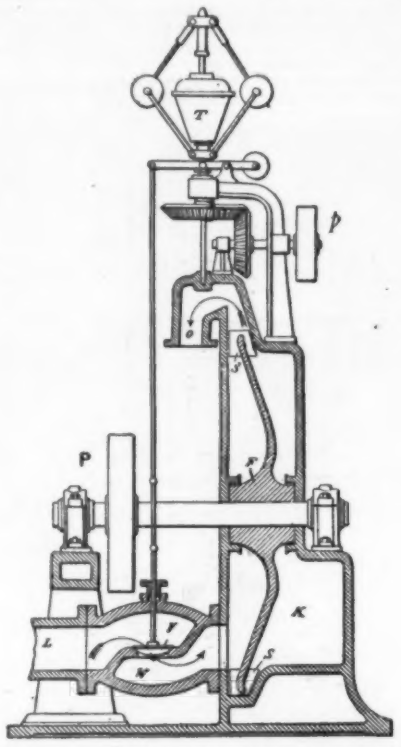


Fig. 1.—THE RÜSCH-SENDTNER HYDRAULIC GOVERNOR—VERTICAL SECTION.

water raised by the wheel, *F*, returns to the reservoir through the conduit, *L*.

When the motor is running at a normal velocity, the valve, *V*, is closed, and the drum, *K*, is practically empty, so that the resistance of the air is exerted solely upon the wheel, *F*.

When the velocity increases, the regulator gradually opens the valve, *V*, which permits of the entrance into the drum, *K*, of the water coming from the conduit, *L*. Then the wheel raises this water by means of its paddles up to the outlet, *O*, in operating after the manner of a centrifugal pump. It is evident that the larger the quantity of water that is sent into the drum, the greater will be the increase in the work expended in raising it to the exit orifice, and this will naturally tend to diminish the velocity of the motor in proper proportions. After the normal velocity has been re-established, the governor will close the valve, *V*, and all the water will soon run out of the drum.

In the practical form given to the apparatus (Fig. 2), the reservoir and drum constitute two compartments of a chest forming an integral part of the frame and surmounted by a horizontal centrifugal governor. In the upper part of the drum are formed several channels for the discharge of the water into the reservoir.

Since the work absorbed is converted into heat, it becomes necessary to cool the apparatus if it be continuously overdriven. If there is a conduit of cold and clean water disposable, it will suffice to renew the water of the reservoir at proper intervals of time. Any other method of cooling, however, may be employed.

When this apparatus is driven by a belt, it is mounted upon grooved crosspieces provided with set screws that permit of regulating the tension of the belt. In this case it is preferable to have the ball governor actuated directly by the motor, in order to avoid the inconveniences that might result from the slipping of the belt. If the apparatus is coupled directly with the motor, the regulator may be connected with the shaft of the latter through a belt.

It is claimed for this apparatus that it is very sensitive. The passive resistances in running idly are very feeble—scarcely four per cent. of the maximum energy that the governor is capable of absorbing.

The shafts are made of steel and the anti-friction metal bearings are provided with an automatic lubricating ring. No other part is subject to wear. The running is done in silence, and no surveillance is necessary.

The manufacturer guarantees that, following an instantaneous throwing into or out of gear, the total variations in the number of revolutions, even in the case of the maximum of energy capable of being absorbed by the governor, will not exceed 2½ per cent., and that at half of such maximum the variation will be reduced to 1¼ per cent.

Upon modifying the velocity for which the ball governor is regulated, the apparatus is capable (starting from the minimum that the slowest running prescribes) of lending itself to wide variations in the maximum rendering. Thus, type No. 1, making 440, 620, and 860 revolutions, develops 3, 6, and 10 horse power at the brake; No. 2, making 410,560, and 750 revolutions, develops 6, 12, and 20 horse power; and the largest model of the series, making 170, 210, and 340 revolutions, develops 100, 200, and 400 horse power. It will be seen that this interesting apparatus is adapted for use in all hydraulic installations, however extensive they may be.

For the above particulars and the illustrations we are indebted to the Revue Industrielle.

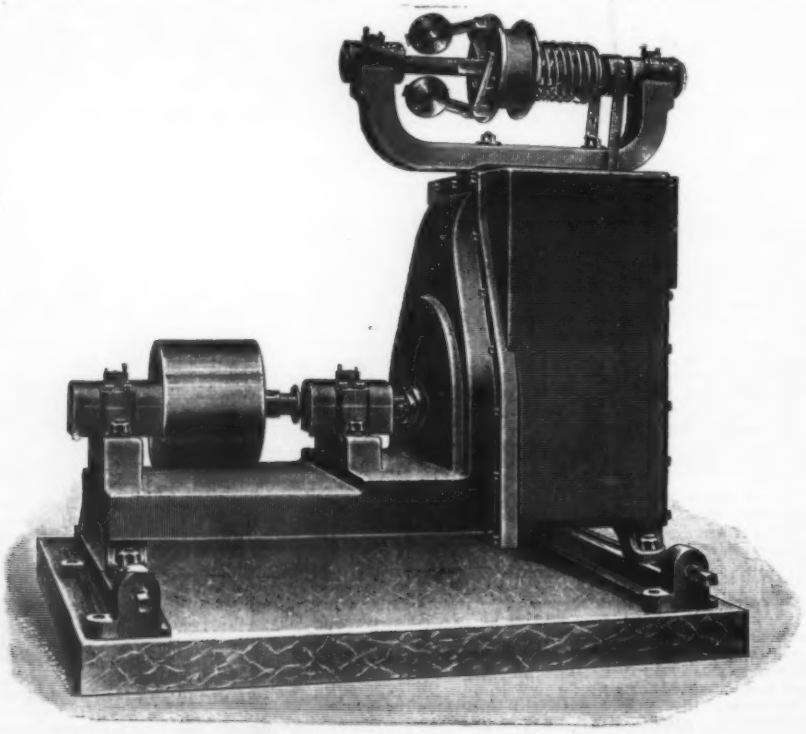


Fig. 2.—THE RÜSCH-SENDTNER HYDRAULIC GOVERNOR—PERSPECTIVE VIEW.

HOW TO PREVENT BRITTLENESS IN SOFT STEEL SHEETS.

John E. Stead concludes a paper, read before the Iron and Steel Institute, which is illustrated with a series of plates, as follows, says The Iron Age:

The whole study and work on the subject of crystalline iron was made in order that we might ascertain the conditions leading to the development of brittleness, and so find out what to avoid, and also to ascertain if anything could be done afterward by any special treatment to convert brittle material into steel, tough and reliable. In the more recent investigations of brittle sheets the following facts have been noted:

1. Occasionally one end of a sheet may be tough and good and a portion of the other more or less brittle. In one case examined there was found to be no difference in the composition between the two varieties. Presumably we must conclude that the conditions of annealing were not absolutely identical. It is difficult to see where or how such a difference could occur, unless we assume that the thermal conditions were unlike and responsible.

2. That sometimes one side of a sheet is brittle, the other being quite tough.

3. Sometimes the outside is brittle and the inside tough.

4. There are cases in which the outside envelope is tough and the inside quite brittle.

These cases where, in the small width of about $\frac{1}{4}$ inch, there existed both brittle and tough material must put an end to the supposition that difference in chemical composition is in any way an important factor.

Heating the rolled sheets up to 900° C. followed by slow cooling would undoubtedly give tough material; but 900° C. is so high a temperature, the annealing boxes would suffer rapid destruction if heating to so high a degree were adopted.

It will no doubt occur to many that if rolling the sheets in one direction only is the initial cause of rectangular weakness, rolling at various angles, so that one latent impression may be neutralized by a second, that brittleness would be in that way avoided. It would, of course, be impracticable to roll in such a way to any extent, at least without making a circular sheet, and with our present plant it would be impossible. It appears probable, however, that if the last two or three passes were made alternately at angles of say 15° in the longitudinal direction, first on one side and then on the other, the tendency to develop brittleness would be greatly reduced, if not eliminated. Such treatment would undoubtedly result in sheets of irregular shape and a consequent greater production of scrap; it is not likely, therefore, that advantage will be taken of it.

It has already been mentioned that sheets of twenty-two and higher gages never develop rectangular brittleness, and that it is only in the thicker sheets it is obtained. What is the cause of this difference? Does the rolling continued beyond a certain point destroy the latent arrangement set up before that point is reached? This question we cannot answer with our present knowledge.

The whole problem is surrounded with many practical difficulties, and it is certain that until we have means at hand of practically controlling and determining the temperature for forty-eight and more hours of the annealing pots it will be useless to continue the study. The fact that contiguous parts of the same sheets differ materially in brittleness, the composition being the same in each part, and that different parts of the pots vary in temperature, would lead us to believe that proper temperature is the all important factor.

The one important point which we may consider to be established is that phosphorus should not be allowed to exceed about 0·08 per cent. A sample of steel which was exceedingly brittle in rectangular lines,

and which, although it was annealed repeatedly, still maintained its brittle cleavage character, contained :

	Per cent.
Carbon	0·11
Manganese	0·345
Silicon	trace
Sulphur	0·090
Phosphorus	0·128

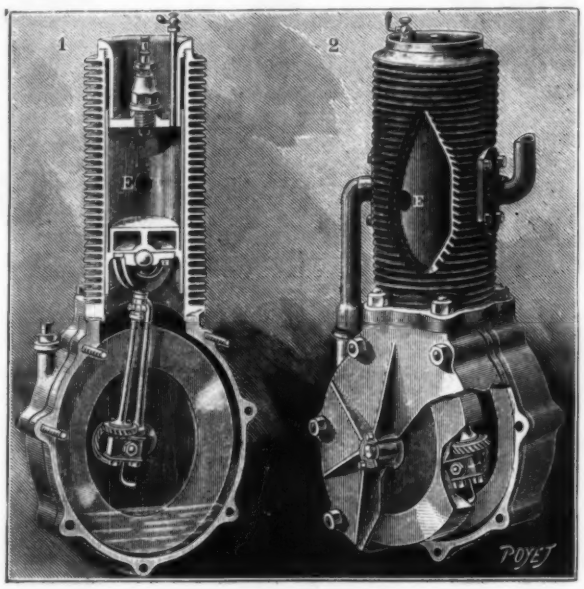
In conclusion, it must be admitted that the study of this most important subject is not only of the highest scientific interest, but of the greatest practical importance. It would be well if more attention were paid to it, and it is hoped that the results recorded in this note will stimulate others to follow up the investigation.

THE DAWSON GASOLINE ENGINE.

THE general tendency of modern mechanics is toward simplicity, and this has never been better shown than it has within the last few years in the construction of gasoline motors, without which the automobile would not yet exist, since electricity, the rival of gasoline, has scarcely taken its first step in this direction.

After the suppression of valve gear, an endeavor was made to suppress the valves themselves, and the motor that we are about to describe is one of the most interesting and original of any of those that have, up to the present, been constructed with that end in view.

The Dawson rotary motor is, like all others, based upon the explosion of a mixture of air and vapor of gasoline by the application of the four period (or Beau de Rochas) cycle. As the accompanying figure shows, the motor has no valves, valve slides, or delicate gear in the parts exposed to the explosions and high temperatures. The piston, which has the form of a long steel tube, assures the different phases of admission, explosion, and escapement by revolving during its stroke, and, through an aperture, *E*, in its side, by alternately opening and closing distributing ports properly arranged upon the cylinder. Each of these points of the piston thus describes a helicoidal, alternating motion in making one revolution and four alternate strokes, and causes the crank shaft to make two revolutions. The revolution of the piston converts the sliding into a "tacking" motion, the advantages of which, from the view point of the reduction of losses through friction, have been shown by the remarkable experiments of M. Raffard. The long, hollow form given the piston presents a certain number of advantages from the standpoint of guiding, and especially of leakages, which the great length of the piston reduces to zero, since its stroke is finished before the gases have been able to traverse the extremely narrow space between it and the cylinder. The piston has no packing, and, thanks to its rotary motion, slides very easily.



THE DAWSON GASOLINE MOTOR.

Finally, since the explosion takes place in the interior of the piston, the hot gases do not come into direct contact with the walls of the cylinder. The cooling of the latter is effected through wings when the motor is less than 3 h. p., but by a circulation of water when the power is greater.

The explosive mixture is, as a general thing, ignited by an electric spark and the usual processes, although, if preferred, it may be ignited by incandescence in arranging at a proper point upon the cylinder a tube heated to redness in front of which passes the orifice, *E*, of the piston.

The shaft, crank, and fly wheels are arranged in a hermetical chest, which constitutes the frame upon which the cylinder is fixed.

The connecting-rod head plunges into oil contained in the chest and projects it on every side, and thus assures the lubrication of the cylinder. The connecting-rod head and the special mechanism that revolves the cylinder are lubricated through a small tube which, at every revolution, enters the oil in the bottom of the chest and takes up a little of it.

For the above particulars and the illustration we are indebted to La Nature.

A permanent paste for paperhangers may be produced by dissolving one ounce of alum in one part of warm soft water. When cold, add flour to make it about the consistency of cream, then add half a thimble of resin and half an ounce of sugar of lead. The above are the proportions for a bucket of paste.—Western Painter.

THE ACTION OF ELECTRICITY ON PLANTS.*

By E. H. COOK, D.Sc., F.I.C.

THE destructive effects of electricity of high potential upon plants needs no demonstration. It is only necessary to remember the wrecks which are made of our finest forest trees by a single flash of lightning to call vividly to mind the enormous power of the discharge. But the action of smaller quantities at lower potentials has not been extensively studied. True it is that from time to time we hear of wonderful results being obtained, and marvelous experiments being made. In many of these cases, undoubtedly, exaggeration has been indulged in, and the attitude of the scientific man has become very much that of the skeptic. This is unfortunate, because there is undoubtedly something in the subject, although the unraveling of the facts is surrounded by peculiar difficulties, involving complicated and extremely prolonged experimentation.

For some considerable time the idea that electricity might have some influence on the growth of plants seems to have been simmering in the minds of many experimenters. Thus, in 1806, the great botanist, De Candolle, experimented for a long time, but without arriving at definite results. Other experimenters also tried, but no results seem to have been obtained until Naudin used means for supplying electricity from an external source to the soil in which the plants were growing. He claims to have obtained increased effects. The experiments of Sir William Siemens with the electric light are well known, but some of the most important have been made in Russia by M. Spechnew, and in France by several agriculturists, of whom, perhaps, M. Barrat and M. Paulin may be mentioned. In these cases the experiments have been made on the large scale, and have extended over many years.

The experiments recorded in this paper were commenced so far back as 1886. They have been repeated many times as the conditions affecting the results gradually became known. They may be considered under three heads : (1) Those relating to the germination of seeds ; (2) those relating to the growing of plants in soil ; (3) those dealing with the lower forms of plant life, such as algæ, fungi, etc.

1. Influence on the Germination of Seeds.—Numerous experiments were made in order to see if any effects could be obtained with constant or intermittent currents and with high or low tension electricity. Taking one mode of experimenting as a type of the whole, a current of electricity varying from 1 to 10 milliamperes was passed by means of carbon plates through moistened grains either of barley, wheat, peas, or other seeds contained in beakers. Side by side with these were placed similar seeds through which no current was passed. The current was switched on for about two hours daily. The results were sometimes indefinite, sometimes extraordinarily successful, but the general effect was to give an increased development in the electrified seeds amounting to from 10 to 20 per cent. more than in the non-electrified ones.

Experiments were also made with a view of discovering whether constant or intermittent currents were best suited to accelerate the growth. It was found that no advantage could be obtained by constant currents over intermittent ones, and in some cases the constant current was not beneficial.

High-tension electricity was tried by subjecting the seeds to electrification from a Wimshurst machine inside glass vessels before planting. The results obtained showed that in this way a larger proportion of seeds germinated, but the electrified showed no increased growth over the non-electrified.

2. Influence on Growing Plants.—The experiments on seeds showed that with a suitable amount of electricity at a suitable E. M. F. the germination was accelerated ; it then became necessary to determine whether, after the plant was formed, any increase in the rate of the processes of assimilation and absorption took place. For this purpose experiments were tried with seeds planted in similar soil and in similar pots. Through some of these a current was sent between carbon electrodes, while the others were allowed to grow in an ordinary manner. Experiments were tried with intermittent and continuous currents, and with a variety of seeds. In almost every case the electrically urged plants came to maturity first, but they were also the first to show above the soil, and I could not satisfy myself that, with the currents employed, viz., from 1 to 30 milliamperes, and with an E. M. F. of 5 to 25 volts, any increased rate of growth was observable after the cotyledons appeared above the soil. In other words, an electrically urged plant grown from seed in soil will show above the soil, say, four days before one not so urged ; but after that the electrically urged plant will maintain its four days' start throughout—it will not gain after the first start. Therefore, practically, in growing plants in this way, no advantage is obtained by continuing the application of the electricity after the first appearance of the green leaves. This, of course, applies to electricity of low E. M. F.

Experiments were now tried to find if the same peculiarity held for electricity of high E. M. F. For this purpose the discharges from the Wimshurst and from the induction coil were employed. Moreover, the effects of the positive and negative were tried separately. The results showed that with the machine a much increased rate of growth is obtained when the E. M. F. varies from 25 to 40,000 volts ; moreover, that the positive always produced the greater effect at first, but that the negative rapidly caught up and took the lead. It was also noticed that with this kind of electricity certain kinds of plants, such as bulbs, could be accelerated which could not be influenced by the current. In one of these experiments on hyacinths, the color of the blossom produced under the negative was distinctly different to that of the positive, as well as to that of the non-electrified. Possibly this may be caused by the larger amount of ozone produced by the negative discharge.

In order to compare the effects of the battery, the induction coil, and the machine, experiments were made with the same seeds grown, (1) without any electricity, (2) with a current passing between carbon electrodes, (3) under the positive point from a Wimshurst machine, (4) under the negative from the same, (5) under the positive point of an induction coil, and (6) under the negative point of an induction coil. In every case the positive end of the coil produced the greatest effect. This was with an E. M. F. of approximately 45,000 volts.

Experiments with Low Forms of Plant Life.—Experiments have been made with yeast, spirogyra, and other large celled fresh water algæ.

With yeast the rate of development was measured by the rate of evolution of the carbon dioxide. With this substance (yeast) only the current from the battery has been tried as yet. The results were somewhat indefinite, but an increased effect was produced within a very limited range of E. M. F. and quantity. The complete conditions regulating the growth have not been fully studied, but are still under examination.

The effect upon spirogyra was tried with the current, and with positive and negative spraying from the coil and machine. Microscopic examination was continually made in order to see if any alteration could be observed in the end cell of the filament, and also if the process of conjugation was hastened. No definite conclusions could be reached in reference to either. In some instances it was thought that accelerated growth was produced, but repetition of the experiments failed to confirm the results.

In the case of the current, electrolytic effects took place, gases being evolved from the platinum electrodes.

Great care had to be taken in the spraying with the electricity from the machine, because the fibers of the plants were found to be readily broken up at the junction of the cells, and it was difficult when this occurred to judge of the change in growth of the fibers. It is intended to continue these experiments.

Application on the Large Scale.—Experiments have been made by M. Barrat and M. Spechnew by connecting large plates of copper and zinc sunk in the soil with a wire, and growing plants between, and also by connecting plates to a battery. It is, however, evident that if atmospheric electricity could be employed, a practically unlimited source is available. Beckeinstener was the first to try this. Following him, several experimenters in France and other countries have invented, perfected and used what has been called the "Géomagnétifère," with remarkable results. The instrument is practically a lightning conductor set up in the middle of a field, and connected below with a series of cross wires running under the soil near the roots of the plants.

The results obtained with this instrument are remarkable. Thus, to quote two well authenticated experiments : A "Geo." was set up in a field adjoining the main road from Montbrison to Montroud, of 8·5 meters high, and made its influence felt over a circular area of 20 meters radius. Within this area was marked out two squares of 4 meters side, and the potatoes growing in these patches were compared with those growing in two equal sized patches in another portion of the same field. The potatoes grown in the two squares within the area weighed 90 kilos ; those grown outside weighed 61 kilos. The number of plants were practically equal. Again, in another case, 60 potato plants grown near the wires of a "Geo." gave 63 kilos, 100 grammes of tubers, whereas 60 plants grown in the same field, but away from the "Geo.," gave only 35 kilos. This gives a difference in the money value of about £8 16s. per acre. Both these experiments are well authenticated. In view of these results it was determined to make a trial in Clifton. Accordingly, in the early spring, M. Pinot de Moira, who is an excellent amateur gardener, as well as a scientist, was induced to put up a "Geo." in his garden on Clifton Hill. Potatoes, beans, tomatoes, peas, etc., were grown near the wires and in other parts of the garden. A distinctly increased effect was observed in all cases near the wire, thus confirming in some measure the results of the French experimenters. The crop of tomatoes is remarkable ; on some plants the number of fruits is between 90 and 100, all well developed. For plants growing in the open air this is remarkable. Unfortunately, it was impracticable to grow unelectrified tomato plants to compare with these under similar conditions. It is, however, much to be desired that further and continuous experiments should be carried out.

Theories to Account for the Action.—Before attempting any theorizing, it was thought advisable to thor-

* Abstract of a paper read before the British Association, Section A.—From The Electrician.

oughly establish the facts. Much time has, therefore, not been given to the testing of supposed explanations. One of the first ideas would be, that the rise in temperature would, perhaps, cause the effect. Very delicate thermometers plunged in the soil showed no rise in temperature; moreover, it can be calculated that, with the strongest currents employed, the rise in temperature would not exceed $\frac{1}{10^5}$ of a degree per hour—an amount too small to produce the effects noted.

Another theory which has been proposed by Specknew is, that a process somewhat like electrolysis goes on in the soil whereby the nutrient material is broken up into compounds which are more readily absorbed by the roots of the plants. In support of this, he cites several experiments which he has made. In confirmation in experiments made to test this, I found in the neighborhood of the positive electrode the earth was slightly acid, whereas that near the negative was faintly alkaline, thus proving the existence of an electrolytic action. But obviously this explanation will not account for many of the effects, and, in fact, the subject is so wide, that many different actions are probably at work, and it will be necessary to multiply the experiments, and to know more of the conditions, before satisfactory explanations can be given. As a step in this direction, the experiments recorded in this paper are considered to show that a particular plant requires for its maximum development a distinct strength of current and of a definite potential.

SUBMARINE CABLE GRAPNELS.

By CHARLES BRIGHT, F.R.S.E., A.M. Inst. C.E.

THE ground over which submarine cables are laid, and from which it may be necessary to recover them, being of many different kinds—rock, sand, mud, clay, etc.—it is obvious that there must be, in recovering a cable, many different grapnels to suit various requirements. But since both rock and mud are frequently found in the same locality, it is evidently impossible to restrict the use of any particular grapnel solely to the purpose for which it is designed. Thus, in fact, many grapnels are actually intended for both hard and soft bottoms. The chief characteristic of those designed for rocky ground is that they are so constructed that a broken prong is readily replaced by a new one, or—as in the latest form—the prongs are self-relieving and regain their normal position when the obstruction is passed.

In describing grapnel apparatus, it is convenient to divide them into three classes:

1. Those which owe their peculiar construction to the fact that they are essentially rock grapnels.
2. Those which are designed for very soft mud.
3. Grapnels designed for some special purpose, such as cutting and holding a cable without regard to the bottom over which they may be required to work. These we shall call special grapnels.

It would be impossible to describe every grapnel in detail, or to dwell on its respective merits under the peculiar circumstances for which it is designed; and therefore the illustrations must, to a great extent, speak for themselves. Most of the grapnels referred to have been used on a large scale in practice and with complete success. Extracts from engineers' reports and logs, giving particulars of the results, afford, of course, above all, the most satisfactory evidence; but though in many cases these have been available, it has been found impossible to include them here. References are, however, made to some of those which have been published.

Rock Grapnels.—The most simple form of submarine cable grapnel is that modeled after the pattern of the ordinary grapnel, such as is frequently used to anchor boats. It differs from this in having a longer shank, so as to insure the prongs plowing through the ground at an even depth, and in having no flukes, since these would only offer unnecessary obstruction. On an emergency the ordinary boat's grapnel anchor can readily be converted into an efficient cable grapnel by cutting off the flukes of the prongs, and either shortening or lengthening the prongs themselves according as the ground to be worked over may be hard or soft.

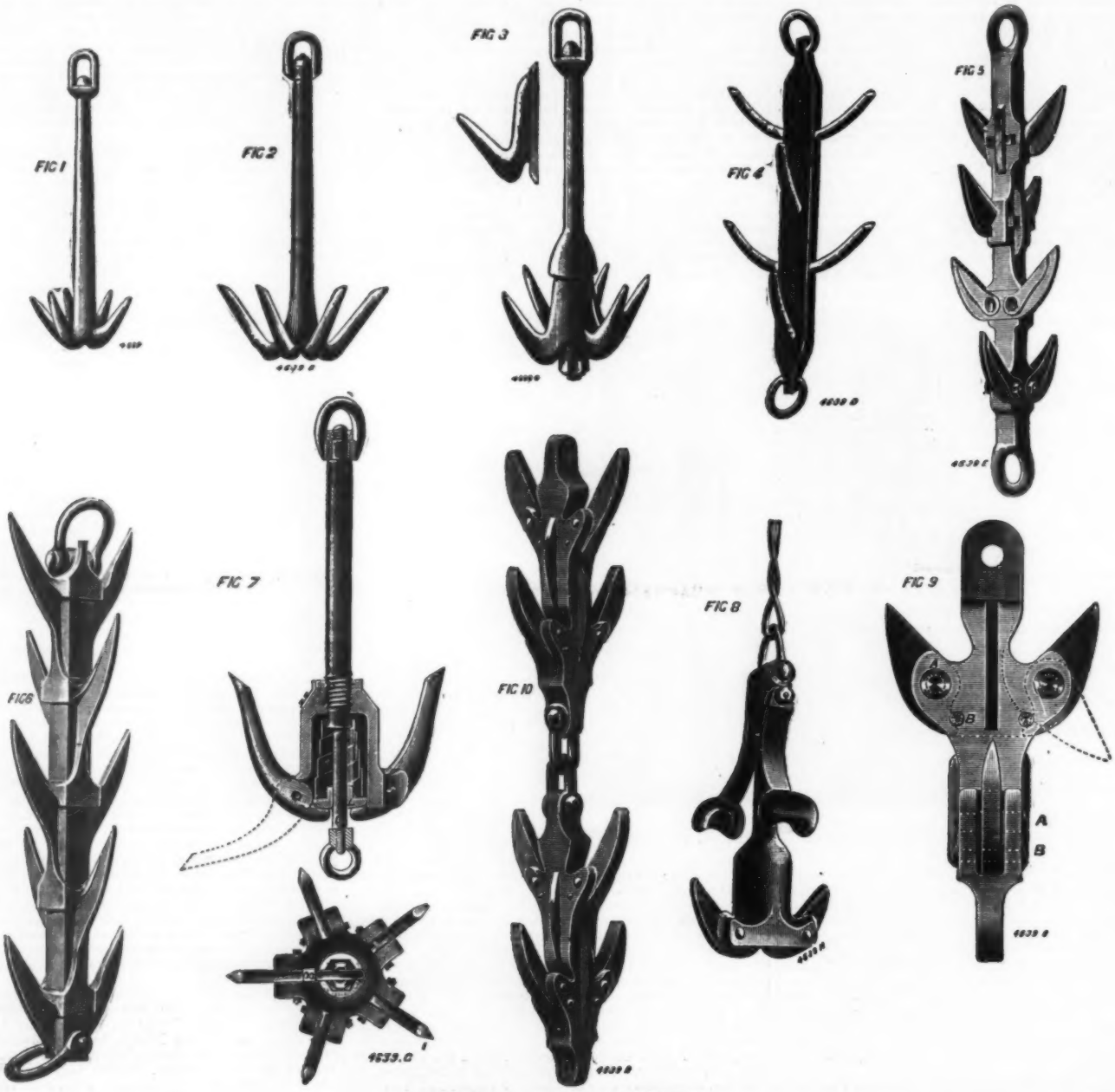
Common Short-Pronged Grapnel.—This is shown in Fig. 1. The prongs, or toes, as they are sometimes called, are very short and strong; but nevertheless are frequently either broken or bent. It is, therefore, necessary to have a large stock of such grapnels on board, if this kind is to be solely depended on. The weight of the grapnel is from 1 cwt. to 5 cwt. Springs are sometimes attached to the shank, so as to prevent the cable escaping from the prongs when once it has been hooked. This short-pronged grapnel is only suitable for rocky or hard bottoms. Fig. 2 illustrates another form of the ordinary grapnel, but with longer prongs for finding the cable in softer bottoms.

Common Grapnel with Renewable Toes.—This grapnel, shown in Fig. 3, was designed by the Telegraph Construction and Maintenance Company, and is a most useful one. To change a damaged toe, the nut at the bottom end is unscrewed, a new toe inserted; and, on again screwing up the nut, the grapnel is ready for work. The damaged toe may then be repaired at leisure.

Common Centipede Grapnel.—This consists of a heavy bar of iron about 4 feet long with a number of holes in it, alternately at right angles to one another. Through these holes bars of iron are forced outward and afterward bent so as to form prongs (see Fig. 4). The prongs, when broken or bent, are readily replaced by new ones. This form of grapnel is, however, almost obsolete.

Cole's "Centipede."—This is shown in Fig. 5. The toes are made of cast steel, and are bolted on to the shank in pairs. The design of this grapnel, though an improvement on the ordinary "centipede," is not, perhaps, entirely satisfactory.

Sliding Prong "Centipede."—In this grapnel (Fig. 6) the prongs, which are made in pairs of malleable cast steel, are so constructed that they slide on to the shank, which is square in section. When a prong breaks, a repair is readily effected by taking off the shackle at the end nearest to the break, and slipping a new pair of toes on. An objection to this grapnel, as usually constructed, is that the surface on which the cable rests when hooked is not sufficiently large,



SUBMARINE CABLE GRAPNELS.

and is liable to cause a cable to break just at the point where it is held.

Centipede grapnels, as well as others, are provided with a ring at the tail end, so that a short length of chain can be attached. This has a good effect in reducing the jump of the grapnel caused by its catching on rock, and, consequently, disengaging suddenly, on the strain increasing or the lead of the rope becoming more vertical.

Jamieson's Grapnel.—In December, 1875, while repairing the Para-Pernambuco section, the idea occurred to Prof. Andrew Jamieson, F.R.S.E., that a grapnel might be constructed with self-relieving prongs, so as to give way when engaged with rocks, but so arranged that the prongs should automatically assume their normal working position immediately after slipping over the rocks. Mr. Jamieson mentioned his idea to Mr. W. F. King, who was then engineer-in-chief to the Western Brazilian Telegraph Company, and, together with him, designed a form of grapnel to effect this object.

Fig. 7 shows the grapnel as originally patented, and its working will be readily understood. On the prong, *I*, fouling the rock, it turns on its pivot, the heel of the prong compresses the volute spring, *K*, until when the prong arrives at the position shown in the dotted line, the obstruction is slipped, and the prong immediately springs back to its normal position.

Subsequently, Prof. Jamieson made important modifications in this form. Again, a further departure was effected later, as illustrated by Fig. 8. In this there are but two prongs, and a collapsible stock is provided to insure one or the other of them working. This grapnel is, in fact, very much like an ordinary anchor in principle, except that both the flukes and the stock temporarily give way on encountering an obstruction. For a further description of Mr. Jamieson's ingenious grapnels, see his paper on "Cable Grappling and Lifting," read in 1878.*

Stalibrass' Grapnel.—In this grapnel, shown in Fig. 9, the prongs are pivoted, and normally held in position by a soft iron pin, *B*, against which the heel of the prong butts. On encountering rock, and on a sufficient strain coming on to the point of the prong, the soft iron pin shears, and the prong capsizes into the position shown in dotted line, and slips off the obstruction. The strain at which the pin shears can, of course, be approximately adjusted to any desired figure.

The general design of the grapnel is very cleverly arranged, so that a capsized toe tends to turn the grapnel over and prevent it towing the disabled side down, as invariably happens with grapnels of ordinary construction. So long as one prong remains in its normal position, the grapnel can be relied upon.

Two very distinct advantages are gained in this apparatus, without sacrificing any of the simplicity so essential to a good grapnel, and without the use of springs. As will be seen, the grapnel is made short, so that it can be used as a four-pronged grapnel, or a pair can be connected together (Fig. 10) by a short length of chain and used in place of the ordinary "centipede" grapnel. When hooked, the cable rests on a large rounded surface and is saved from damage. The resting place is on the shank of the grapnel, so that should a prong subsequently foul a rock and become capsized, the cable is not lost.

* Journal of the Society of Telegraph Engineers, vol. ii.

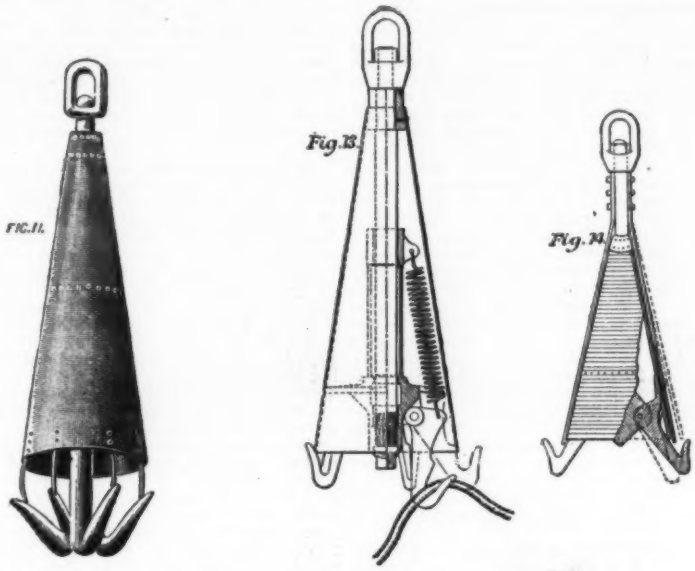
Dutton's Grapnel.—On a hard, rocky bottom a cable is not likely to be buried in the ground; and there is, at any rate, no need for anything but a very short toe. For some reason or other, however, it is not uncommon to keep the toe a fair size and reduce its projection by means of a guard fastened round the shank. An arrangement due to the late Captain Dutton is very generally used, and is shown in Fig. 11. The spring guards mentioned above to keep the cable from unhooking itself, can be seen here.

Mance's Grapnel.—Sir Henry Mance, in 1885, patented the use of separate guards to each of the prongs to prevent them engaging themselves too deeply in rock, etc. Speaking generally, however, guards of this description are unfortunately somewhat liable to become displaced.

Johnson's Collapsible Prong Grapnel.—This grapnel—in outward appearance very much like the Dutton grapnel—is provided with prongs pivoted to the shank, which, under normal conditions, project beyond the edges of the conical shield which forms the body of the grapnel. Should any of the prongs come in contact with rock they recede within the shield sufficiently far to enable the grapnel to clear the obstruction. The pivots of the prongs are so arranged that a very slight movement of the points is sufficient to bring them completely under the protection of the shield, and—as is the case with King and Jamieson's and with Stallibrass' grapnels—if a prong is forced back after the cable has been hooked, it still retains the cable perfectly. A special point claimed by the inventor is that as the prongs collapse inward, should the grapnel become foul in a narrow channel between rocks, it stands a better chance of clearing itself. Fig. 12 shows a general view of the grapnel, and Fig. 13 a sectional elevation.

An improvement on Johnson's collapsible prong grapnel was suggested by an anonymous correspondent in The Electrical Review for January 11, 1895. In this (Fig. 14), besides the prongs receding behind the Dutton guard, an additional movable guard is provided to each prong, and is placed outside close on to the other. A slot is cut in the Dutton guard, so that the heel of the prong butts against the outside guard, and on the toes fouling rock, the prong turns on its pivot, and its heel causes the movable guard to advance and lift the grapnel off the obstruction. The dotted lines in the figure show the position of the prong and the guard just after an obstruction has been cleared. The extreme simplicity of this grapnel cannot fail to recommend it.—Engineering.

(To be continued.)



SUBMARINE CABLE GRAPNELS.

EXPERIMENTS WITH CURRENTS OF GREAT FREQUENCY.

M. P. DOSNE, the author of an article on wireless telegraphy which we recently borrowed from La Nature,* communicates to that journal a few details as to the arrangements that he employs for the production of currents of great frequency.

A Ruhmkorff coil, *B* (Fig. 1), giving a 4-inch spark, communicates with the interior armatures of two Leyden jars, *C*. In the center of the latter there is a bent copper rod, which is prolonged by a chain in the interior of the jar. The sparks from the oscillator appear at *a*. The external armatures of the jar communicate with a disk of zinc provided with a terminal. From each terminal starts a copper wire 0·08 of an inch in diameter connected at the extremities with a solenoid surrounding a wide mouthed jar 6 inches in diameter. In the center of this jar there is a cardboard cylinder 1 inch in diameter upon which is wound an insulated wire 0·08 of an inch in diameter. One of the extremities of this wire is connected with a small rod and the other with a stand, *E*, made of zinc. When the oscillator, *a*, operates, currents of great frequency are obtained at the exit from the transformer, *D*, and an intense field results therefrom at *E*. Geissler tubes placed in the field become illuminated, and a series of experiments may be performed. Another transformer may be had by adopting the arrangement shown in Fig. 2. In the interior of an ebonite tube 2 inches in diameter, around which is wound fine insulated wire, is fixed a small wooden cylinder carrying a solenoid of naked copper. The whole is placed in a glass cylinder provided with a special stopper. This tube is then filled with petroleum.

It is possible easily to obtain a certain quantity of ozonized air by stretching a platinum wire in the interior of a glass tube (No. 2, Fig. 2) and connecting its extremities with the source of rays of great frequency. The glass tube is covered externally with tinfoil. Finally, through the tube, *a*, is compressed a certain quantity of air making its exit at *Z*.

Another arrangement also has been adopted by M. Dosne for the production of ozone. Into a wide glass tube enter an electrode formed of a tube terminating in a perforated funnel and a second electrode formed of a tube provided with a brush at its extremity. Between these two electrodes occurs a powerful silent discharge. If a current of air be sent into the tube, it will make its exit strongly ozonized.

REMEDY FOR DIFFICULTIES IN BURNING ACETYLENE GAS.

PROF. VIVIAN B. LEWES, an eminent English chemist, who has done much valuable work in extending our knowledge of the properties and applications of acetylene gas, has lately contributed an interesting paper on this general subject to the (English) Society of Chemical Industry. In this communication he deals at some length with the difficulty which exists in finding a suitable burner in which to consume the gas, and throws much light upon the cause of the difficulty. All who have had experience with acetylene are familiar with the fact that there is a persistent disposition to the deposition of soot in the burner tip, which, in course of a short time, causes the clogging of the tip, followed by the distortion of the flame and pronounced smoking. Numerous efforts have been made to do away with this objectionable feature, but thus far with only partial success. Among the remedies that have been proved most satisfactory is the Naphey burner and its various imitations, but these have proved to be by no means infallible, and the difficulty appears to be as far from solution as ever.

Prof. Lewes has studied the character of this soot

* SCIENTIFIC AMERICAN SUPPLEMENT, No. 1192, page 19106.

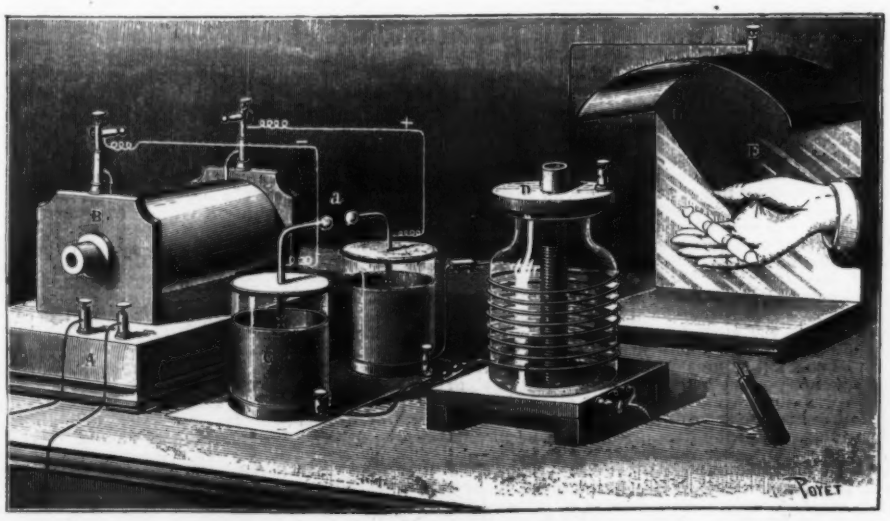


FIG. 1.—APPARATUS FOR EXPERIMENTS WITH CURRENTS OF GREAT FREQUENCY.

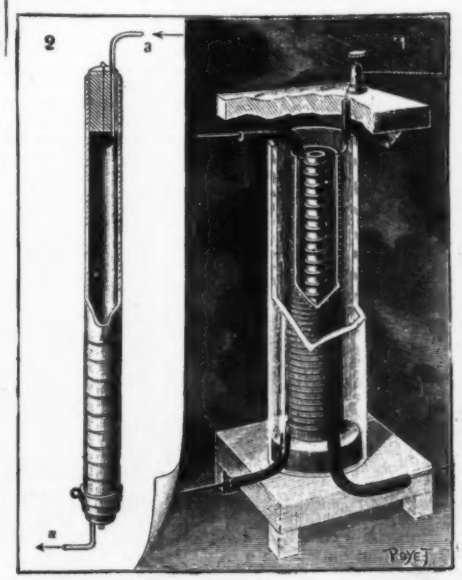


FIG. 2.—1. ANOTHER STYLE OF TRANSFORMER. 2. OZONIZER.

deposit, and offers some explanations of its nature and cause, which point to the proper remedial measures.

It has been generally supposed that the soot deposit noticed in the burner slit or tip consuming acetylene was due to the dissociation of the gas from overheating at the nipple, the decomposition resulting in the separation of carbon. Prof. Lewes believes this is not the true explanation of the origin of this deposit.

On breaking open the steatite tip of such a burner, he found a carbonaceous deposit extending for a considerable distance into the body of the steatite, and this he holds to be evidence of the fact that the deposit has been caused by deposition of liquid hydrocarbon, which has soaked into the steatite and been carbonized there. He calls attention to the fact that the same trouble is experienced to some extent with carbureted water gas, when, owing to insufficient temperature in the cracking and superheating chambers, the carbureted gas contains vapors instead of permanent gaseous products. His observation leads him to the belief that the trouble in the case of acetylene arises from a similar cause, namely, the presence in the gas of condensible hydrocarbons, the origin of which he explains as follows:

"When acetylene has been made in a generator at an undue temperature, it carries with it benzene vapor, which, as it commences to condense, assumes a vesicular form (like smoke or tar vapor), and on coming to the extremely minute holes which form the apertures of the burner, the mechanical scrubbing which it encounters causes the breaking up of the vesicles and the deposition of the benzene and other hydrocarbons held in suspension in the gas, which soak into the steatite, and carbonize. The presence of finely divided carbon has a great effect in determining the decomposition of acetylene itself, so that a rapid growth of carbon takes place at the burner, and no ordinary cleaning from the exterior will ever make the nipple fit for constant use again."

The remedy for the trouble, Prof. Lewes believes, must be sought for in the improvement of the automatic acetylene generators in service, with the object in view of avoiding undue heating in the process of generating the gas. If proper attention is paid to this point, not only will the sooting of the burner be largely avoided, but there will also be obtained an appreciable increase in the yield of the gas from the carbide. His conclusions are expressed in the following terms: "It will be found with experience that the prevention of smoking in a burner will be effected quite as much by attention to the temperature in the generator as to the burner itself, and where a generator is in use which gives overheating, a well arranged scrubbing apparatus that would get rid of the benzene in the gas would be found a distinct advantage in stopping burner troubles."

The practical hints herein given by Prof. Lewes should prove of the utmost value to those who are engaged in the manufacture of acetylene machines and the users of the gas.

GERMAN STUDIES OF MALARIAL DISEASE.

THE German Colonial Society, one of the most important of several permanent associations at Berlin which are devoted in one way or another to the systematic development of Germany's colonial possessions and the foreign trade of the empire, has taken up with great energy the suggestions of Prof. Koch as to the necessity of more effective measures for studying and mastering the malarial diseases which now so seriously restrict the settlement and impair the value of the colonies in Africa and the East, which have been acquired and maintained at such cost of effort and outlay.

It is recognized that public hygiene, among the climatic conditions which exist in tropical countries, presents difficulties for which special preparation and provision must be made. Medical officers who are sent out for service in such countries must have a special scientific training in the diagnosis, treatment, and prophylaxis of malarial disease. This has now been provided for by a special course of study at the Institute for Infectious Diseases, of which Prof. Koch is the technical chief; and a number of young physicians who are preparing for colonial service are already at work under the direction of the great bacteriologist. When their special studies are finished, these physicians will go to their posts of duty in the colonies, each provided with a special outfit of scientific apparatus devised by Prof. Koch, and will be thus equipped to take up and continue the observation, record, and study of malarial diseases, upon the result of which so much of the future value of Germany's tropical colonies will depend.

Besides these preparations for prolonged and systematic observation, Prof. Koch has appealed to the Prussian Ministry of Medical Affairs, to which he is officially subordinate, for two further scientific expeditions, to be organized and conducted under his personal direction, for the purpose of completing thoroughly the preliminary studies which he has made in Italy, Africa, and India. According to the announced plan, one of these commissions will be limited to three months and be assigned to the study of malaria in Greece and Italy, in which countries the climatic conditions are to some extent influenced by bad drainage and unsanitary habits of the people in old and badly constructed cities.

The second expedition is to occupy two years and make an exhaustive study of malaria at the deadliest fever districts of New Guinea, East Africa, and India. The keen interest manifested in this whole subject by the Prussian Ministry and Imperial Foreign Office, and the wide attention that has been attracted by Prof. Koch's reports of his preliminary studies of malaria in tropical countries, encourage the belief that both the proposed expeditions will be authorized and their respective missions carried out in accordance with Dr. Koch's specifications.

He has recently left Rome, after six weeks of study in the hospitals where are treated cases of Roman and Campagna fevers, and in which he has been aided by the foremost specialists of Italy. As a result of these studies, it is now declared that the malarial fevers of Italy are identical in cause and general character with those of East Africa, and it is believed that science is on the eve of a decisive victory over this whole group of maladies by means of liquid injections of quinine into the pulse vein. The importance of this discovery to Italy will be evident from the fact that of the sixty-nine departments into which that kingdom is divided, only six are absolutely free from malaria, and 1,200 square miles, including some of the most fertile districts of Italy, are, like the whole southeastern coast of Corsica and much of Sardinia, practically uninhabitable on account of malarial disease.

Among the other interesting deductions of Prof. Koch is his freely expressed opinion that the indiscriminate use of quinine as a prophylactic in malarial countries is attended with great danger, and is in many cases the indirect cause of the pernicious "blackwater" fever, one of the most virulent forms of malarial disease. The very general practice among persons coming from temperate to tropical latitudes of saturating their systems with quinine taken in regular and often excessive doses is vigorously condemned, for two reasons: first, because it seriously weakens the action of the heart, and, second, because the system, having become inured to the drug, fails to respond to quinine treatment in case of actual sickness. The efficiency of the drug having been exhausted as a preventive, it has no longer any important value as a remedy; and experience shows that a person debilitated by the excessive use of quinine may take malarial fever and die of it like anyone else. Prof. Koch even goes so far as to assert that the increased death rate in certain portions of West Africa, where the conditions of living have been greatly improved during the past ten years, is due largely to the increased and indiscriminate use of quinine caused by its greater cheapness and the ease with which it can now be obtained. He also states that on the western coast of Africa, where all forms of malarial fever are especially virulent, cases of the intermittent type which have resisted even heroic doses of quinine have been mastered by the use of arsenic. It is well, however, to remember in this connection that a certain antipathy to quinine and a preference for arsenic as a remedy for certain fevers is a marked and well-known peculiarity of the German school of medicine, in respect to which its opinions are in sharp disagreement with those of physicians in some other countries, notably the United States.

Another fact noticed and mentioned by Prof. Koch during his studies in Africa and India is that women withstand exposure to malarial climates far better than men. During the appalling mortality on the Gold Coast, within the past four years, says the report, there was hardly a death among the women living out there, while every kind of man was dying—men new to the tropics, men born in them, men who had been accustomed to them for years, even men who had battled with the ravages of West Africa for upward of ten years.

The attempt to explain this anomaly by the fact that men are, as a rule, more exposed to the hot sun of day and the miasma of night, failed in the presence of the fact that the death rate was highest among officials, merchants, and employes who work in offices, banks, and warehouses, where no exposure to weather is involved and where medical attendance, food, and all conditions of living are the best attainable in that country. The fact that black-water fever, so deadly to male Europeans, almost never attacked women, and that no physician has yet offered any reasonably conclusive explanation of such discrimination, illustrates how far medical science is yet from a full understanding of malarial disease, and how long and difficult a road is yet to be traversed before the risks incurred by northern civilization in the effort to reclaim and civilize the tropics will be reduced, through exact knowledge and scientific practice, to a minimum.

The subject is certainly so important as to invest with world-wide interest the efforts that Germany is now making under the lead of her foremost bacteriologist to reach a clear understanding of, and more potent mastery over, the scourge which now makes desert some of the fairest and most fertile portions of the earth.

FRANK H. MASON,*
Frankfort, October 11, 1898. Consul-General.

THE DREADED PTOMAINE.

PTOMAINE is a generic term for alkaloid bodies formed from animal and vegetable tissues after putrefaction sets in and similar bodies produced by pathogenic bacteria. The word comes from the Greek word *ptoma*, which means a corpse. Most of the putrefactive changes to which ptomaines are due occur in dead bodies, but they also occur in living bodies. Some alkaloids are very poisonous, some less so, and others not at all. Just as soon as nutrition stops in an organic or inorganic substance putrefaction sets in. As soon as a flower or vegetable is plucked, it begins to decay; as soon as flesh, fish, or fowl is dead, putrefaction begins. So you see it is impossible to avoid the consumption of ptomaines. We take in a great many poisons in our food without knowing it, fortunately for our peace of mind. We eat a lot of tainted meats without ever suspecting that they are not perfectly fresh, and every man who enjoys a piece of cheese gets a certain amount of poison, for cheese is full of ptomaines. In truth, the richer the cheese, the more ptomaines it contains. From this one can readily see how impossible it is to avoid this bugaboo of ptomaine poisoning if we look at it in the abstract.

Science does not deny that people are frequently poisoned by ptomaine; but it does deny that this poisoning is fatal. Cases where death has resulted show the inability of the system to eliminate the poison rather than the direct action of the poison itself. Take the case of the noted musician, Anton Seidl. Why was his wife not poisoned also, for she ate of the shad roe which was supposed to have killed him? It happened that in his case some of his organs were affected by other ailments and the poison could not be thrown off. Nature protects her children from poisons consumed with food by eliminating them through the kidneys, liver, intestines, and skin. This is clearly shown in cases of cholera morbus, due to eating food undergoing putrefaction. Severe vomiting, diarrhea and retarded respiration are the symptoms, and all show the stupendous efforts Nature makes to eliminate the poisons.

Some foods are better mediums for the transference of ptomaine poison to human beings than others. Again, certain foods poison certain people. Some persons cannot eat fish, some strawberries, others cucumbers, and so on, but this rather shows an individual weakness. Perhaps the skin cannot do its work in eliminating its share of the poison, and so fish or berries cause some people to have an eruption of the skin. In almost all cases of ptomaine poisoning it is found that the eliminating organs, particularly the kidneys, are the real source of trouble. Certain ptomaines belong to a healthful body which the kidneys and intestines eliminate. If these remain in the blood through the failure of these organs to get rid of them, they will poison as sure as a dose of arsenic. Then, too, certain ptomaines are necessary for the digestive process and even the nutritive process. These start fermentation by altering the conditions of certain complex bodies by splitting them up into simpler compounds, making the food more easily digested and nutritious. So you see, ptomaines have their good as well as their bad points.

Nature protects us from some of the most poisonous foods by creating a disgust for their taste or odor or both. She guards her animals in the same way. They avoid eating poisonous plants because they have an instinctive distaste for them. Nature is not going to allow her family to be decimated by shad roe, oysters, ice cream, or anything else. Ordinary food is not liable to get ptomaines where proper care is taken of it. Where food is frozen, thawed out, and frozen again, it is very dangerous. Cold storage is responsible for many ptomaines. We eat chickens that have been kept in cold storage a year, and put there without having had the intestines removed at that. Think of it! These are hung up in the market. We buy them and eat them, and nature eliminates the poisons that they convey to the human system.

This is one of the dreadful penalties of civilization, and the concentration in large cities that makes such a thing possible. There is very little harm in hung meats in cold weather, for the micro-organisms that get in their work in cold weather are not very dangerous. Fish is very apt to decompose rapidly, more rapidly than ordinary flesh, and putrefaction is indicated by a stale, tainted taste that is apt to make one ill, but does not kill. Oysters, unless perfectly fresh, are very poisonous, and when oysters look glazed, have a coat of mucus over them, the person who is about to eat them may be sure that putrefaction has set in, though it may not yet be perceptible to the taste. Oysters and fish may begin to putrefy before they are taken from the water, but even so, if eaten immediately are less apt to hurt the consumer than those that begin to putrefy after being out of the water. Nothing is more rife with ptomaines than the track of a shot in a bird. Everybody has tasted that rank, cheesy, bitter taste in partridge, grouse, or quail. Again, it may be that a bird is suffering from ptomaine poisoning from eating some kind of berry or vegetable before it is shot, and if this is the case it is much more apt to transfer ptomaines to the consumer than a bird that was perfectly healthful when killed.

At certain periods of decomposition these ptomaines are poisonous, and at others they are not. After decomposition sets in, when one set finishes its work, another takes it up at once. To prove the former statement there is the case of a French butcher who killed a pig on a Friday and sold half of it to another butcher. The latter sold his half to a large number of customers, who ate it on Monday and Tuesday, and seventy people were made violently ill by the meat. It was made into sausage, I believe. Eight died. The police heard of this and forbade further sale of the poisoned meat. Butcher No. 1, who still had his sausages on hand, determined not to waste them, and concluded to feed them to his family and himself. On Wednesday they ate of the meat and were not made in the least degree ill.

We often hear in the summer, for instance, that large numbers of persons have been striken down at a picnic. Generally the fact is developed that only those who ate of certain meat or ice cream were poisoned. In the noted case at Wappinger's Falls the wholesale poisoning was said by some to be due to tainted ham; others claimed that it came from the copper cooking vessels. Copper has been used for cooking utensils for centuries, and there is no authenticated case of copper poisoning on record. However, the process which ends in the production of ptomaine poison can be started by unclean vessels, as well as in disease and changes in temperature. Housekeepers cannot be too careful about seeing that all cooking utensils and receptacles for food and drink are absolutely clean. Old countrywomen believe that thunder sours milk. It isn't the thunder that does it, but the sudden change in temperature which comes with a thunderstorm. It is most necessary to keep milk, meats, and even vegetables and fruits at an even temperature, for thus is the danger of generating ptomaines lessened.

We rarely hear of tyrotoxicon or cheese poison, and yet cheese, as I stated, is full of ptomaines. Many persons who eat rich cheeses suffer from indigestion, which is frequently a mild form of ptomaine poisoning, but it passes away because the organs are in a healthy condition and there is sufficient vitality to resist the poison. The man who eats a piece of cheese runs just as much risk of being attacked by ptomaines as he who dines on shad roe. And the girl who takes her big dish of strawberries and cream runs an equal risk. The race would soon be extinct if it were not for this force of vital resistance. Ptomaines frequently develop in cattle before they are slaughtered. Cows that are driven a long distance or are crowded together and boxed up in cars, without food or water, for days at a time, are very apt to develop them. The same is true of human beings. When man or woman is overworked—or, better, overworried, for few are overworked—and that exceedingly tired feeling takes possession of the body, alkaloids are forming there. Whether the person falls ill or gets better depends on the amount and strength of the vital resistance.

Appetite is the sentinel for digestion. If any food gives the proper countersign to the appetite, let it pass along the line. If you want a thing to eat, no matter when or how or where, eat it, for it won't hurt you. Nobody ever dies from eating. It is almost impossible

* United States Consular Reports.

to eat too much and be comfortable afterward. Even the smallest child knows when to quit. Indigestion warns us all. There is a great deal more scare than actual scientific knowledge about ptomaine poisoning. Few ptomaines have been isolated by chemical tests and there may be hundreds yet to be discovered and separated. In the meantime we need not be so curious as to what they are so long as we can take our hung beef, shad roe, and cheese with a relish. Our parents got along very well with the ptomaines and why shouldn't we? Let us keep well and take our chances; there is nothing to fear.—Dr. George F. Shrady, in The New York Sun.

CALCIUM.

By Sir ROBERT BALL, F.R.S., in The Humanitarian.

WHO does not remember the delight of the first occasion in his childhood when he was permitted to peep into a bird's nest and there see a group of eggs, often so delicately marked or so exquisitely tinted? How beautiful they appeared lying in that cozy receptacle constructed with such art and concealed with such cunning! I shall never forget when as a small child I happened to peer into a furze bush on the Obelisk Hill at Killiney and there saw a hedge sparrow's nest with five blue eggs. Their lovely hue seemed almost a reflection of the azure on the April sky over that beautiful spot.

Among other sweet recollections of early youth many of us may recall an early ramble by the seashore. The tide had retreated, and with other objects left by the sea on the gleaming sand a little cowrie shell is spied. How enchanted we were with the curiously wrought markings on its lips, and with the inimitable beauty of its tints! We remember the joy with which we brought home our treasure, and how long it remained one of our most cherished possessions.

But my reason for mentioning the shell of the egg and the shell cast up by the sea is because they have another quality in common besides that of beauty. The egg of the hedge sparrow and the shell of the cowrie have both been fabricated essentially from the same material. Lime is, of course, the substance with which the bird by some subtle art of physiology forms those exquisite walls by which the vital part of the egg is protected. The soft organism that dwelt in the cowrie had some power by which it abstracted from the sea water in which it dwelt the lime with which the inimitable shell was built up. Is it an exaggeration to say that this peculiar substance, lime, seems to enjoy a special distinction in its association with works of exquisite grace and beauty? The white marble wrought to unparalleled loveliness by the genius of a Phidias or a Canova is, of course, but a form of lime. The stones of the Parthenon contain lime. There is lime in the mortar which holds those stones together.

Though lime in its many forms is one of the most ordinary substances met with on this earth, yet the essential element which goes to the composition of lime is not by any means a familiar body. As is well known to everyone who has learned any chemistry, lime is the result of the union between oxygen gas and the metal calcium. This very remarkable element calcium is, however, never found in nature unless in such intimate chemical union with some other element like oxygen or chlorine that the characteristic properties of the metal are disguised. To see calcium itself, you must go to the chemical laboratory, where by ingenious processes the shy element is temporarily divorced from its union with the oxygen or other body for which it has so eager an affinity.

For though calcium is certainly a metal, yet its properties make it very unlike the more familiar metals such as gold or silver, copper or iron. A coin might, perhaps, be formed out of calcium, but it would have no endurance like the coins of the well known metals. Calcium has such an unconquerable tendency to unite with oxygen that such a coin could only be preserved by taking special precautions to withhold it from air or from any other source whence it could obtain the element whose union would transform it into lime. Thus it happens, that though this earth contains billions of tons of calcium in the form of lime, yet we seldom see the metal itself.

Though most of us have never even seen a particle of calcium, it may well be doubted whether there is any element more important to the economy of this earth or more widely distributed over it. Calcium abounds in every soil. Calcium is in the waters of the sea. The cup of spring water owes much of its invigorating freshness to the calcium which it holds in solution. The white cliffs which have given the name of Albion are but one of the many forms of calcium.

Try to imagine what this earth would be like if calcium were withdrawn. The birds could not lay eggs. The sea could produce no shells. Man and other animals would need to have bones very different from those which they at present possess. Buildings would in great part vanish. Even the hills and mountains would to a considerable extent disappear. Probably a very large part of the total mass of this earth would be taken away if all the calcium were to be removed.

It is thus plain that calcium plays a part of tremendous significance on this earth. I do not say that it is the most important of all the elements. It would indeed seem impossible to assign that distinction to any particular element. Both oxygen and hydrogen are, of course, needed for every drop of water. Carbon is an essential constituent in the composition of any organic substance. There are, no doubt, certain of the rarer elements with which perhaps this earth could dispense without being to any appreciable extent different from what it is at present. I do not know that we should be specially inconvenienced, or in fact have any appreciable want unsatisfied, if all the lanthanum which this globe contains were to be struck out of existence, and there are of course several other elements about which the same remark might be made.

Without calcium a world inhabited in the same manner as our present abode would be clearly impossible. There are, it may be, lowly organisms on this earth to which calcium is apparently of no appreciable consequence, and it is conceivable that a world of living types of some kind could be constructed without the aid of that particular element which is generally so indispensable on our globe. But such a world would be totally different from that world which we know. Under present conditions the significance and importance of calcium in our economy can hardly be overestimated. The remarkable position of calcium on the earth being recognized, we have now to add that this same element appears to be also of the utmost importance throughout the universe.

We are, perhaps, at present living too closely to the time to be able to appreciate fully how great is the marvel of the most characteristic discovery which has been made in astronomy during the course of the present century. There can hardly be a doubt that the greatest achievement of this science within the time named need not be sought in any fresh development in the older departments of astronomy. The greatest advance of astronomy in this century has led to the acquisition of an entirely new province of work for the astronomer.

In the early part of this century it might have been said—indeed, by a certain very distinguished philosopher it actually was said—that a limit could be assuredly laid down which would bound the possibilities of our knowledge of the heavenly bodies. We might, no doubt, study the movements of these different orbs. We might calculate the forces to which those orbs were submitted. We might, with the help of mathematical analysis, ascertain the various consequences of those forces. We might thus determine where the various orbs were situated at illimitably remote epochs in the past. We might calculate the position which those orbs might attain at epochs to be reached in the illimitably remote future. We might map down and survey the distant parts of the universe, and we might obtain their pictures on our photographic plates. We might even sound the depths of space and find how far from us the celestial bodies were placed. We might measure the dimensions of these bodies and determine their weights. We might add scores or hundreds to the list of the known planets. We might double the list of our nebulæ or make measurements of twenty thousand double stars. We might even essay the sublime task of forming an inventory of the stars in the universe and of compiling a catalogue in which the stars and their positions would be recorded in their millions.

"But," said the philosopher to whom I have referred, "though you can perhaps go thus far, yet a limit to your possible achievements can be certainly indicated. You need never expect to discover the materials of which the heavenly bodies are composed." Nor could anyone at the time dispute the reasonableness of this statement. Indeed, it seemed to be a necessary deduction from our knowledge of the arts of chemistry as in those days these arts were practiced. The chemist in the prosecution of his delicate and skillful researches could analyze a body and discover the materials of which the body was formed. That is to say, his art enabled him to analyze the body, provided, however, one very essential and fundamental condition were complied with. The chemist of those times, however accomplished he might have been, would surely have thought he was being mocked if, when asked to determine the composition of a body, he was told that he could not be supplied with a specimen of that body; that, in fact, there was no specimen of that body nearer than a distance of ninety million miles. The very idea of performing an analysis under such a condition would in the early part of this century have been scouted as silly and preposterous. "Deliver into my hands," the chemist would say, "a specimen of this body. A specimen which I can take into my laboratory. A specimen which I can pulverize in my mortar, place in my test tubes, treat with my reagents or examine with my blowpipe." In that way alone, according to the chemical arts as they were known in those days, would it be possible to obtain an analysis of the body and discover the elements from which that body was formed. For in the early part of this century that splendid method of studying the secrets of nature known as spectrum analysis had not yet come into being. It requires a mental effort to realize how enormous was the enlargement of the possibilities of chemical analysis when that new method was available.

To take perhaps the simplest illustration of the new analysis, let me mention the element sodium, the metal which, in combination with chlorine gas, forms ordinary salt. It was long observed that sodium had the power of imparting to flame a brilliant yellow color. When the spectrum of sodium flame was examined, it was seen to be composed essentially of a pair of yellow lines. It was noticed that these particular lines were invariably produced by sodium when that element was placed under proper conditions. It was also found that these lines were never produced by any other element except sodium. Thus these lines afforded a method of testing the presence of this particular element. When these lines were found, then sodium must be in the flame which gives rise to the lines; when the lines were absent, then sodium was absent. This was presently perceived to give astonishing enlargement to the resources of the chemist. But not at first, perhaps, was the full extent of its capabilities realized. It was indeed a ready method for him to discover the presence or the absence of sodium from a particular solution. He dipped a clean platinum wire into a solution, exposed that in his Bunsen flame, and viewed the resulting light through his spectroscope. He was still, however, in this investigation given the solution to be examined. He thus had the specimen to be tested in his possession. To this extent the new method was therefore like the old one, in which the possession of the actual specimen was required.

But it was soon perceived that as the spectroscope required no actual contact with the body itself which was to be tested, but only wanted the rays of light which that body dispersed when sufficiently heated, this new method of analysis would be capable of a further and enormously enlarged application. The flame producing the sodium vapor might be at one end of the room, while the test might be made at the other end. It was thus possible for this new and beautiful optical instrument to test the presence of sodium in a flame twenty feet distant, but, if twenty feet, why not twenty yards, or twenty miles, or twenty million miles? Why could it not be used if the source of light were as far as the sun, or as far as a star, or even as far as the remotest nebula whose faint gleam like a stain of light in the sky is all that can be seen with our mightiest telescope?

Here was indeed a most notable and astonishing enlargement of our possibilities of knowledge of the constitution of the sun and the stars. I have used sodium merely as an illustration, for what is true of sodium is also true, with certain modifications, of the other elements also. No longer was it necessary to have a specimen of the body in our possession as an indispensable preliminary to making an analysis of its composition. With this new method at his disposal, the chemist only needed the rays of light from that body when heated to such a temperature as to make it emit its characteristic radiation. It mattered not that the beam of light after being specially marked at its source had to travel illimitable millions of leagues of space. Its characteristics remained uneffaced so long as the brightness remained sufficient to give a visible impression of the spectrum.

As the study of this subject extended, it was soon found that a spectrum visible to the human eye was not always indispensable for the study of the source of light. The photographic plate, which so frequently replaces the eye with great advantage in other classes of observation, has also been used to replace the eye at the spectroscope. A picture is thus obtained of the characteristic lines in the spectrum of a celestial object. That object may have been sunk into space to a distance so tremendous that even though the light traveled at a pace sufficient to complete seven circuits of our earth in each second of time, yet rays from the object in question may have been traveling for centuries before they reached our instruments. During the whole course of that prodigious voyage the light preserved its credentials. It was dissected, so to speak, by the prism on the spectroscope, and the several rays were conducted to their distinct positions on the photographic plate. There they engraved their characteristic signs. Nature has thus set down for our instruction an inscription which it is our business to interpret. It is true that these inscriptions are not always easily deciphered. Many of them indeed have not yet been understood. But enough has been learned to conduct us to a truth of wide generality.

Our globe is composed of innumerable substances, which, however, can be resolved into a comparatively small number of distinct elementary bodies. Considering the insignificance of our earth when viewed in comparison with the millions of other orbs in the universe, considering also the stupendous distances by which the earth is separated from innumerable much greater globes, we would hardly have anticipated that the elements which go to the composition of our earth should be none other than the elements which go to the composition of these distant bodies also. But this is what has actually been found to be the case. Some of the very elements which are most common on the earth are also most abundant in orbs lying in the remotest parts of the universe. No element is, of course, more familiar than iron on this earth, and it is interesting to learn that this same element iron is a characteristic of the sun, and it is also found in many of the stars. We may also mention another element of a very different character. Hydrogen gas is also a body of the utmost consequence to us on the earth. It is the presence of this same gas in prodigious abundance which gives a special character to the radiation from Sirius and other brilliant stars of the same intense whiteness. To take a third instance of an element of a class quite different from either iron or hydrogen we may mention carbon, which is so intimately connected with all vital phenomena. This same carbon appears to be of widespread significance. It courses in the comets through the remote depths of space. It is also abundant in the sun, and doubtless in many other bodies also. It may, indeed, be said that the results of these inquiries has been to show that the elements of which the heavenly bodies have been built are substantially the same elements as those of which our earth is formed.

Attention has already been drawn to the importance of calcium on the earth. We have now to add that this same element appears to be most widely distributed among the various bodies in the universe. Among the most remarkable features in the photographic spectrum of the sun are two very broad and very dark and very conspicuous lines. In every photograph of the ultra-violet light of the sun, these lines stand forth so boldly as to arrest attention more than any other feature of the spectrum. It had been known that these lines were due to calcium, but there were certain difficulties connected with their interpretation. Same recent beautiful researches by Sir William and Lady Huggins have cleared away all doubts. It is now certain that the presence of these lines in a spectrum demonstrates that the remarkable element which enters into the composition of lime on this earth is also in the sun. These same lines have indeed been detected in the photographic spectrum of many other bodies. Thus the interesting fact is established that this particular element which plays a part so remarkable on our earth is not peculiar to our globe, but that it is diffused far and wide throughout the universe.

FORMULÆ FOR TEST PAPERS.*

POTASSIUM Ferricyanide and Citric Acid.—The papers have likewise the property of precipitating albumin from urine.

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Wurster's Tetramethyl-paraphenyldiamine Paper.—Filter paper impregnated with tetramethyl-paraphenyldiamine. Assumes an intense bluish-violet color in the presence of traces of active oxygen in neutral or acetic acid solution. Reagent for ozone and peroxide of hydrogen.

Reagent Paper (after Geissler and Oliver) for Detecting Albumin.—(a) Picric and Citric Acids. A precipitate results if a strip of the paper is dipped into urine containing albumin. (b) Sodium Tungstate and Citric Acid: The presence of albumin, mucin, uric acid, peptones, and creatinine is revealed by a precipitate resulting after strips of the above paper have been dipped into the urine.

Detection of Sugar in Urine.—Indigo Carmine and Carbonate of Sodium Papers.—These papers furnish the Mulder reaction (a successive green, red, and yellow coloration) in the presence of sugar in urine.

* From the Pharm. Post; Pharm. Journ.

Griess Test Paper.—Filter paper saturated with an alcoholic solution of metaphenylene-diamine. Gives a yellow to brown color reaction in the presence of nitrous acid and nitrites.

Griess Red Test Paper.—Filter paper saturated with an alcoholic solution of sulphanilic acid and alpha-naphthylamine hydrochloride. The presence of nitrous acid and nitrites produces a dirty red coloration of the paper.

Palladium Chloride Paper.—Swedish filter paper saturated with a solution of palladium chloride. Reagent for coal gas, carbureted hydrogen, carbonic acid, etc., shows liberation of metallic palladium.

Phenol Phthalein Paper.—Filter paper impregnated with an alcoholic phenol phthalein solution, employed as indicator in alkalimetry.

Phloroglucin Vanillin Papers.—Filter paper saturated with alcoholic solution of phloroglucin-vanillin, employed as a reagent for detecting the free hydrochloric acid of gastric juice.—Deutsch-Amerik. Apoth. Ztg., xviii., 100.

Azolitmine Paper.—A reddish-violet bibulous paper impregnated with azolitmine. It is colored red by acids, blue by alkalies.

Lead Acetate Paper.—Filter paper saturated with a solution of neutral lead acetate, for detecting the presence of sulphureted hydrogen.

Lead Glazed Paper.—Glazed paper impregnated with carbonate of lead, for detecting the presence of sulphureted hydrogen.

Brasiline Papers.—Filter paper impregnated with a solution of indigo carmine, for detecting oxygen.

Red Carmine Paper.—Paper saturated with a solution of ammonia carmine, an indicator of acids, giving a yellowish-red color reaction.

Curcuma Paper.—Filter paper saturated with an alcoholic tincture of turmeric. Indicator of caustic alkalies and alkaline earths, giving a reddish-brown color reaction. It is colored brown by boric acid, sulphur-yellow by acids. Sensibility for KHO about 1:180,000; for NH_3, 1:35,000.

Fuchsine Paper.—Paper saturated with an alcoholic fuchsine solution, employed for detecting sulphuric acid.

Dahlia Paper.—Filter paper impregnated with an alcoholic solution of the coloring matter of Dahlia variabilis. Indicator of acids and alkalies.

Hæmatoxylin Paper.—Filter paper saturated with aqueous solution of hæmatoxylin. Extremely sensitive indicator for ammonia, alkali, alkaline earths, and certain metals.

Bilberry Paper.—Paper saturated with an alcoholic or aqueous extract of bilberries. Employed as an indicator of ammonia and fixed alkalies.

Blue and Red Litmus Paper.—Very sensitive indicators obtained by immersing filter paper in a neutral alcoholic litmus tincture. Sensibility of red paper for KOH, 1:20,000; of blue paper for HCl, 1:50,000.

Cobalt Paper.—Filter paper impregnated with cobalt chloride and methyl blue solution. Indicator of zinc, copper, and nickel.

Congo Paper.—Prepared by impregnating filter paper with a solution of Congo red. Turned blue by acids. Indicator of free acids.

Albumin Paper.—Paper impregnated with an aqueous solution of albumin. Principally employed in photography.

Lacmoid Paper.—Filter paper saturated with an aqueous solution of lacmoid. Obtainable in red and blue, and used in the same way as litmus paper. The red lacmoid paper is greatly superior to red litmus paper as an indicator for alkalies. It should be kept in a well stoppered bottle, as it is very apt to spoil.

Methyl Orange Paper.—Filter paper saturated with an aqueous solution of methyl orange. Employed as an indicator of acids and alkalies. The methyl orange paper is colored deep brownish-yellow by mineral acids.

Ozone Paper.—Potassium iodide starch paper. (Schonbein's ozone paper.) Filter paper saturated with starch paste, which has previously been mixed with potassium iodide. Gives a blue reaction when ozone is present.

Thallium Paper.—Filter paper saturated with thallous hydrate. Gives a brown reaction when ozone is present.

Boettger's Test Paper.—Filter paper saturated with neutral gold chloride, colored violet in the presence of ozone.

Pole Test Paper.—Unsized paper saturated with an alcoholic solution of phloroglucin-vanillin. The paper, when moistened, turns red when applied to the negative pole of an electric current.

Silver Paper.—Filter paper impregnated with an aqueous solution of silver nitrate. Indicator of chromic acid, arsenious acid, etc. Delicate reagent for arsenic, specially suited for toxicological examinations.

Tropæolin Paper.—Filter paper impregnated with a saturated alcoholic solution of tropæolin. Gives a lilac reaction in the presence of free hydrochloric acid in gastric juice.

Potassium Mercuric Iodide and Citric Acid Paper.—Albuminous urine shaken with this paper gives a voluminous precipitate.

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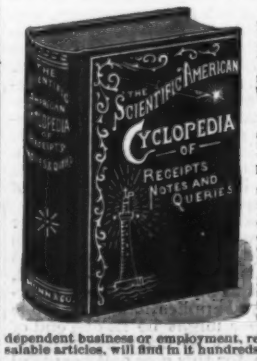

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TABLE OF CONTENTS.

PAGE

I. ARCHÆOLOGY.—Art in Prehistoric Times.—By THOMAS WATSON..... 19219
Roman Construction.—By G. W. PERCY.—7 illustrations..... 19218

II. BIOGRAPHY.—Dr. William Brooks, M.A., F.R.A.S.—1 illustration..... 19220

III. CHEMISTRY.—Calcium.—By Sir ROBERT BALL..... 19229
Formulas for Test Papers..... 19229

IV. ECONOMICS.—The Importation of Gold..... 19220

V. ELECTRICITY.—Experiments with Currents of Great Frequency.—1 illustration..... 19227
The Action of Electricity on Plants.—By K. H. COOK..... 19225

VI. HYDRAULICS.—The Rusch-Sendtner Hydraulic Governor.—Perspective View.—2 illustrations..... 19224

VII. MECHANICAL ENGINEERING.—The Dawson Gasoline Engine.—1 illustration..... 19225

VIII. MEDICINE.—German Studies of Malarial Disease..... 19228
The Dreaded Ptomaine..... 19228

IX. METALLURGY.—How to Prevent Brittleness in Soft Steel Sheets..... 19224

X. MISCELLANEOUS:
Engineering Notes..... 19221
Miscellaneous Notes..... 19221
Selected Formulæ..... 19221

XI. NAVAL ENGINEERING.—Applied Science in the Navy..... 19223
The Austro-Hungarian Armored Cruiser "Kaiser Karl VI."—1 illustration..... 19223

XII. ORNITHOLOGY.—The Gular Pouch of the Great Bustard (Otis tarda).—5 illustrations..... 19216

XIII. SCIENCE.—The Smell of Earth.—By G. CLARKE NUTTALL..... 19216

XIV. TECHNOLOGY.—Remedy for Difficulties in Burning Acetylene Gas.—1 illustration..... 19227

XV. TELEGRAPHY.—Submarine Cable Grapnels.—By CHARLES BRIGHT.—15 illustrations..... 19226

XVI. TRAVEL AND EXPLORATION.—Marchand Before the Pyramids.—1 illustration..... 19216
The Annamite Theater.—2 illustrations..... 19222

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PAGE
MAS WAT-
ons..... 19219
ons..... 19218
-1 illustra-
..... 19220
..... 19229
..... 19229
..... 19220
reat Fre-
..... 19227
..... 19225
overnor.—
..... 19224
oline En-
..... 19225
..... 19228
..... 19228
Soft Steel
..... 19224
..... 19221
..... 19221
..... 19221
vy..... 19223
arl VL"—1
..... 19223
Bustard
..... 19216
TTALL.... 19216
ng Acety-
..... 19227
CHARLES
..... 19226
efore the
..... 19216
..... 19222

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